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FREEDOM OF THE PRESS

THE lively debate on the control and ownership of the Press in the House of Commons on October 29, which issued in a resolution urging the appointment of a Royal Commission to inquire into its finance, control, management and ownership, touched on matters that lie very near the heart of democracy, and which may have a closer bearing on the advancement of science than a superficial examination would suggest. It is not that there is any great enthusiasm for a Royal Commission. On the contrary, few suggested that a Royal Commission could add significantly from the fact-finding point of view to the information already collected in the report issued in 1938 by Political and Economic Planning, and Mr. Douglas Jay was not alone in failing to see that such an inquiry would produce any very substantially useful results. Even if other facts were discovered, he questioned whether they would throw more light on the really essential question whether the present financial control of the Press is interfering with freedom of expression.

That central issue was clearly recognized in the debate. Few questioned that the general tendency for the great majority of newspapers to fall into the hands of a very few men constitutes a serious threat to political democracy. That was explicitly stated by Mr. Haydn Davies in moving the resolution : Could we, or could we not, have real freedom of the Press in a system of combines and chain newspapers ? But among those who agree with Mr. Davies that we cannot, there are still those who doubt whether Government action such as a Royal Commission might invite could be effective without involving worse dangers. What is wrong is not so much the private ownership of the Press, as the use that is being made of that ownership.

If, however, the existence of abuses is recognized, there is little indication of clear ideas as to how they are to be checked. Moreover, as Mr. Driberg pointed out, it is not solely a question of freedom of expression for the writer, but of a part of the general liberties of the citizen, who is entitled to receive accurate news and fair comment. However well-founded may be the belief that the citizen is not getting a full measure of either, no one succeeded in the debate in showing how that measure could be extended without either a direct curtailment of the liberty of the Press or an extension of Government control.

What is required, in fact, is some very clear and constructive thinking at just this point, and it can scarcely be expected that a Royal Commission will go beyond the fact-finding from which such thinking must start. No doubt a further inquiry will again emphasize the interference with freedom of expression which comes from the present law of libel ; and Mr. Mallalieu suggested that a Royal Commission might well look into the question of the way in which freedom of expression and of discussion is hindered by the tendency to exclude the Press directly or indirectly from the proceedings of local councils. Such matters, however, like the better training of

journalists and the higher standard of writing for which Mr. Mallalieu and Mr. Derek Walker-Smith both pleaded, are scarcely matters on which a Royal Commission can formulate proposals. They must come in the main from the professional associations of journalists or from that body of informed public opinion which, recognizing the natural restraints on freedom which are inherent in an organised community, realize also the value of standards evolved from within rather than constraints imposed from without or above.

It could not be said that the opinion expressed in the debate was entirely pessimistic. Some speakers suggested that the position is already better than two decades ago, and Mr. Walker-Smith at least anticipates both advances in technique and in presentation from the production side, and also in the standards which a people whose mind is on the march would demand. Though this comes near the core of the problem, other speakers in the debate showed little consciousness that this whole question is bound up with the wider one of informing the public and assisting the formation of a sound public opinion in a democratic society, to which both broadcasting and the information services which a Government is bound to use have also important contributions to make.

It is the great merit of Francis Williams's "Press, Parliament and People" (W. Heinemann, Ltd. London, 1946. 8*s*. 6*d*. net) that he sets all these factors in their true perspective, and his book should certainly assist in assessing the value of the contribution which a Royal Commission can make. In fact, it is difficult to believe that the report of a Royal Commission could stimulate the constructive and creative thinking, which is our primary need, half so effectively as this lively and timely book. The key problem is not so much that of the ownership and control of the Press, as that of how a democracy can adjust itself to the great and inevitable increase in the concentration of power in the hands of a Government without endangering the personal liberties inherent in a democracy.

That thread is clearly visible in what might well have seemed an interminable debate on the address to the Throne, which well illustrates both the need on the Government side to inform the people of what it is doing in terms that they can understand, and on the other hand the balancing need for highly informed and critical watchfulness on the part of the Press and other instruments of public opinion in order to safeguard the liberties of the individual. As Mr. Williams truly observes, many of the problems of domestic reconstruction are so complex that an almost entirely new approach to the task of informing and explaining policy will be required if the great mass of ordinary people upon whose positive co-operation the success of these policies depends are to feel themselves participants in a common adventure. Moreover, not only is there a need for less secrecy and more information in home and in foreign affairs alike; the debate on certain topics such as the 'closed shop' also underlines the force of Sir Walter Layton's contention in his pamphlet, "Newsprint: a Problem for Democracy", that the present size of the Press, with the consequent limitation of knowledge of public affairs, constitutes a severe handicap to the country. On the evidence of this debate alone, it might be added that it constitutes a danger to personal liberties and to individual justice, apart from the fact that, as Sir Walter observes, "the press of a country is neither healthy nor truly free unless its circulation can respond to the impact of public opinion".

Mr. Williams has much that is pertinent to say about the British press censorship as it was exercised during the War. Emphasizing that it was always voluntary, he points out, too, that it was one of fact and not of opinion. It existed to advise the Press as to which facts could and which could not safely be published without running the risk of giving the enemy information of value in the prosecution of the War. It had no authority to advise the Press as to the opinions they should or should not express. Moreover, while Mr. Williams from his inside knowledge pays a high tribute to the liberality with which the British press censorship was on the whole conducted, he is convinced that censorship of any kind is an instrument to be used only in the most extreme circumstances and with the most rigorous safeguards, and that no Government can be trusted with power to control the Press or the publication of books. Even in the circumstances of war, more damage was done, on the whole, when newspapers accepted directives on policy outside the strict and narrow limitations of press censorship than when they ignored them.

That opinion is well substantiated by Mr. Williams's account of the failure of political censorship during the War. Whereas in the technical and factual field the machinery established for joint consultation and co-operation made for the elimination of clashes and contributed to the success of the censorship, in the political field he argues it cannot be justified. It represents a confession by the authorities of their refusal to trust the people to form sound opinions, and of their unwillingness to allow them to judge between conflicting views and to abide by the result as democracy requires.

The growth of public relation and information services is a much bigger question. Mr. Williams points out how that growth has been accentuated by the War and still more by the measures of social reconstruction to which Britain is now committed; and he shows that Government information services, including such research units as the Social Survey, have a permanent and essential place among those instruments which the executive in a democracy requires to carry through positive measures essential to national and international advance, while the democracy retains those checks upon the exercise of undue authority, those balances and counterbalances which are equally essential to safeguard liberty. We are here straying into that important problem of the organisation of government machinery, and it must suffice to note with Mr. Williams that publicity is no substitute for good administration; it is only effective when the administrative measures it seeks to explain

are sound in themselves. What is essential is that the version of a measure or policy placed before the general public by the information services of the Government shall be fair and unbiased. Public judgment must be formed on the true facts, and not on a partisan presentation of them.

That is an argument for the constant scrutiny of the activities of Government information services, but not for their restriction; and one basic reason for Sir Walter Layton's plea for a more generous supply of newsprint is to enable the Press to play more effectively its part in such scrutiny, and in averting the further danger that under the guise of straightforward explanation and instruction the public may be led to accept as facts what are highly debatable propositions. This is a point which was missed by the unofficial 'working party' under Sir Richard Gregory's chairmanship which prepared for the recent Empire Scientific Conference a paper on the "Dissemination of Scientific Information to the General Public"; but it is one to which scientific workers need to give far more attention. It is one aspect of the obligations which their loyalty to truth demands in that partnership with science as a part of the social contract which in Burke's view constitutes the State. Beyond that it is a duty which they owe to science itself. A bad book was ever the enemy of other books, and in the conditions of to-day it has to be remembered that publication of a book or a periodical which does not meet those high standards of accuracy and impartiality which science rightly demands, may well be hampering the publication of another which does.

That is no reason for return to a censorship. The argument of Milton still stands. But it is imperative that the reviewing of books and the scrutiny of scientific publications of all kinds should be searching and objective, and that neither loose nor tenditious writing, inaccuracy, nor verbiage should escape the criticism it invites. It would be easy to instance recent scientific and technical books which have been too lightly handled in this respect. If the proceedings of the Royal Commission and Mr. Williams's book emphasize that scientific workers have real responsibilities in this field, much good will have been done; and possibly one way opened up for easing that serious position which the shortage of scientific and technical books is causing. It is true that increasing use is being made of broadcasting for the dissemination of scientific news, and scientific men in Britain are showing far more signs of awareness of the immense influence which the B.B.C. can exert in educating and informing the public on scientific and technical matters. The way in which this influence could be exerted and the use of this instrument, by which the mass of the people can learn more about the world in which they live and something about the purpose and significance of the policies their Government has adopted, were among the reasons prompting the desire for an independent inquiry on broadcasting policy which the Government rejected in the White Paper last July.

While, however, broadcasting is one important way in which information on Government policy or on scientific and technical matters can be disseminated, it cannot either replace the printed book or paper, or provide the check on executive action which is the other half of the democratic problem. That part of the problem relates to the machinery of government; this cannot be discussed further here, except to insist once more that any effective machinery of government must be equipped with adequate means of both keeping the executive in touch with the trend of public opinion and of providing the country and the world in general with an honest and truthful picture of the position of the nation and the reasons for its policy. Any form of censorship or control that would restrict the seeking out and disclosure of truth or dam the flow of knowledge, either within any one nation, or between nations, is a fatal bar to the efficiency of democratic government and the understanding between peoples on which all our hopes depend. It is only by a readiness to seek and publish the truth whatever its implications, to enter into frank debate between governed and governing, and between nation and nation, to challenge, to criticize and propose, and to offer to the test of world opinion the principles by which we seek to guide our affairs, that, as Mr. Williams concludes, freedom can flourish.

Until the terms of reference of the Royal Commission are published, it is, of course, not known whether or not its inquiry will embrace the scientific and technical Press as such. Indirectly at least it is clear that the whole question touches the dissemination of knowledge and the advancement of science very closely. Some of the particular problems which it offers to men of science have already been indicated. They on their side have repeatedly emphasized in the past year how closely not merely the advancement of science but also the future of civilization depend on the restoration of the fullest freedom of communication within and between the nations. There is in Mr. Williams's book, no less than in the debate just noted, much that should stir them to the constructive thinking on the organisation and use of information services which the functioning of democracy and the needs of science both demand.

HISTORY OF MODERN CHEMISTRY

Modern Chemistry

Some Sketches of its Historical Development. By A. J. Berry. Pp. x+240. (Cambridge: At the University Press, 1946.) 10*s*. 6*d*. net.

THIS is a history of chemistry that is different. Its title and sub-title indicate quite a new approach to the treatment of the subject. A chemistry curriculum is a crowded affair nowadays, partly because of the rapid advances and immense ramifications of chemistry, and partly because it is not yet certain, in these post-war years, just how the curriculum should be arranged. In this changing period the attempt is almost inevitably made to give students as much information as they can digest, with the result that many scarcely realize that all these advances have been made by men many of

whom are still alive and still contributing to the science. With undergraduates it is especially important that this human side of chemistry should be brought to the fore, even at the expense of selection. Mr. Berry has set out to accomplish this difficult task of attaching a name or names to these achievements in chemistry. It is not an easy task, for naturally personal predilection is bound to occur, but it is well that the British contribution (and at times even the Cambridge contribution) should take its proper place among that from other countries.

An honours student will already be familiar with much that is in this book, but he will be none the worse for re-reading it from a rather different point of view—much of the detail is omitted and therefore the story has a continuity that is lacking from the average formal text-book. The physical side of chemistry is more suitable for Mr. Berry's treatment, and consequently we find chapters on atomic theory, electro-chemistry, stereo-chemistry, radioactivity, isotopes, gas reactions and the nature of solutions. There might have been more, but the variety of topics encompasses most divisions of physical chemistry. In short, the book forms an excellent companion to a good introductory text in physical chemistry, easily read and assimilated by any student even though his studies are already full. Mr. Berry is to be congratulated on putting physical chemistry of the last fifty years into a true historical perspective in a pleasant and painless manner.

H. W. Melville

INTRODUCING SCIENCE

Frontiers of Astronomy

By Dr. David S. Evans. (Sigma Introduction to Science, 1.) Pp. 175+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Science versus Cancer

By Dr. I. Berenblum. (Sigma Introduction to Science, 2.) Pp. 116+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Electrons in Action

By Dr. J. G. Daunt. (Sigma Introduction to Science, 4.) Pp. 151+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Power

By Dr. Martin Ruhemann. (Sigma Introduction to Science, 5.) Pp. 123+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

THE four slender volumes listed above are the first issues of a new series which, under the general title of "Sigma Introduction to Science", aims at raising and satisfying a thirst for scientific knowledge among the general public. The volumes are uniform in format, with that rather dreary-looking make-up to which we have, unfortunately, had to accustom ourselves in this austerity era. Each is illustrated with a set of excellent plates; and each is priced at 6*s*., which seems rather high, if the publishers are aiming at a really extensive circulation. None presupposes any previous knowledge of the subject, and all are free from mathematical equations, at any rate in the text. (Dr. Daunt, after struggling manfully against the temptation through 141 pages, does eventually succumb so far as to quote Ohm's law in an appendix.)

Here the similarities end. Though it is convenient to speak of the non-scientific reader, it is well to remember that since the term applies, unfortunately, to the vast majority of our fellow-countrymen, it embraces every grade of intellect and every variety of interest. Genius itself could scarcely produce a treatise which would satisfy the needs of so heterogeneous a company. An author must select his own company from the mass; and the present authors do not seem to have come to any agreement about the audience they are addressing. There is, perhaps, no particular reason why they should. This divergence of treatment does, however, make it impracticable to give a general recommendation to the series. Each volume will, no doubt, find a clientele; it would be an exceptionally undiscriminating reader who would find them all acceptable to him.

It was almost inevitable that the first introduction should be to astronomy. The public appetite for popular astronomical works appears to be almost insatiable, and for very obvious reasons. "Frontiers of Astronomy" is a straightforward matter-of-fact account of the present state of astronomical knowledge in most of its branches. There is a chapter on the solar system, two on stars in general, another on solar physics; novæ and cepheid variables are not neglected, and galaxies, nebulæ and the like also receive a perhaps somewhat scanty treatment. There is also an excellent chapter on astronomical instruments. Dr. Evans has a talent for clear statement and orderly arrangement, and has had, moreover, not a little experience in the popularization of science. Though necessarily highly condensed, the treatment is clear and logical, and the reader who is prepared to give it the requisite attention will find that the book provides a very sound introduction to a very extensive science.

The reader who has been brought up on earlier popular astronomy should perhaps be warned, as the author indeed warns him in a foreword, that the purpose of the book is to provide information, not to discuss its philosophical or religious implications. Unfortunately, Dr. Evans, in his reaction against what one may call the Jeans–Eddington school, has swung too far in the direction of the Gradgrind philosophy ("You are never to wonder, Louisa!"), and even purely scientific speculations on the universe are often dismissed too summarily with the statement that they are not proved. The framing of hypotheses is the ultimate aim of the scientific worker and the method by which he works. A little more indulgence in this direction would not only have made the book less arid, but would also have given a more balanced view of the subject.

"Science versus Cancer", the second of these 'introductions', is a wholly admirable book and will, we hope, receive the widest possible circulation. The problem of cancer is one in which we are all, quite literally, vitally interested; but there is no subject on which apparently well-substantiated rumours are more prevalent, and authoritative information is more difficult to come by. "What is cancer?", "Is it on the increase?", "Is it hereditary, or is it due to environment?", "Can it be prevented, and is there any cure?" These are questions which are constantly being asked, and sometimes being answered too, with more assurance than knowledge, both in conversation and in the general Press. It was high time that a simple, comprehensible and accurate statement of facts about cancer, so far as they are known, should be given to the public,

together with the evidence on which they are accepted. Dr. Berenblum, in writing this little book, has performed a real public service.

It is not easy for a medical specialist to address the general public on his speciality. He has to hold the balance between arousing unjustifiable hopes and raising unnecessary and paralysing fears. Dr. Berenblum has a steady hand, and a sound judgment, and the balance in this case swings true. As a factual statement of the present position of our knowledge about this most deadly of human scourges, "Science versus Cancer" can be warmly commended.

The book, however, goes further than this. It provides, as the title implies, a most admirable précis of the history and progress of cancer research; surely one of the most difficult, baffling and fascinating fields of investigation ever explored. "One sometimes hears it stated that the layman is only interested in the practical results of research," writes Dr. Berenblum in his preface. ". . . If this is true, it is the result of bad education, and is to be deplored. . . . There is a romance of science which stimulates the mind and satisfies the soul; it also happens to be the surest approach for one's understanding of the truth." This is admirably said, and the editor of this, or any similar series of publications, might well consider issuing it as a general directive to all his contributors.

"Electrons in Action" is not a very apposite title for Dr. Daunt's little book. By a convention, which may be illogical but is now well established, it leads one to expect an account of the behaviour of electrons in the free state—in other words, an introduction to the science of electronics. What we have, in fact, is a descriptive sketch of the basic principles and phenomena of electricity and magnetism, covering (so far as such a large subject can be covered in 150 pages) the whole field from elementary electrostatics to radiolocation. The treatment is entirely non-mathematical, and the author has been at some pains to avoid, so far as possible, the use of technical terms. Imagery and analogy largely take the place of scientific argument. Analogy can be a dangerous tool, and some of Dr. Daunt's analogies seem to have been selected more for their entertainment than their didactic value. His picture of a magnetic field as a dense forest of pine trees, and electrons as little men who are terrified of the gloom and try to get out as quickly as possible, is definitely misleading. Electrons are not "terrified" of magnetic lines of force; on the contrary, they tend to describe circles around them, and Dr. Daunt's electronic men, so far from rushing out of the forest the nearest way, would tend to play ring-a-ring-o'-roses around the trees.

Dr. Daunt's material is well selected, and he keeps a firm grip on the development of the subject. The treatment is more elementary than that of the two preceding volumes of the series, and the author seems to have in mind a class of reader for whom the elementary notions of science have to be made very clear and simple. Within these limits he achieves probably as good a picture of the main outlines of the subject as can be attained without the use of some mathematical argument.

The author of "Power" has, in our opinion, missed an opportunity. There is a definite need for an authoritative, well-documented and widely comprehensible sketch of the power resources of the world, on which our present civilization is built. Without some knowledge of this subject it is impossible to plan intelligently either an Empire or a cottage, and a suitable book on the subject would be widely welcomed. Dr. Ruhemann could, we believe, have written such a book. He knows his subject, and much of the information which we should like to have is, in fact, to be found in his pages, though the search would be less tedious if he had provided the book with an index. Unfortunately, Dr. Ruhemann seems to have formed an unduly low opinion both of the seriousness and the mental capacity of his potential readers, and has adopted a style which is not merely conversational, but also, in places, positively facetious. We do not think, for example, that he adds either clarity or interest to his account of the Rankine cycle by calling the water molecule "George", and having his illustrator picture him (or it) as a little black bottle imp with golliwog eyes. The drawing of the steam engine would, in fact, have been of more assistance to the reader if the artist had left "George" out and put in the essential valves instead. (Incidentally, the whole policy of illustrating the series with humorous sketches is one which deserves reconsideration.)

When he is not striving after humour, Dr. Ruhemann can be both lucid and informative. He has selected his material well, though there are topics on which one would be glad to have the data on which his pronouncements are based. The best utilization of power for human welfare involves considerations other than those of engineering efficiency, and if Dr. Ruhemann (in common with engineers in general) wants the public to "change its habits" he must produce evidence. Would it be presumptuous to suggest that he should read Dr. Berenblum's "Science versus Cancer", and then reconsider his policy? Science can be made fascinating, without invoking the doubtful aid of the comic muse. J. A. CROWTHER

AN ENCYCLOPÆDIA OF PSYCHOLOGY

Encyclopedia of Psychology
Edited by Philip Lawrence Harriman. Pp. ix+897. (New York: Philosophical Library, Inc., 1946.) 10 dollars.

PERHAPS the fairest way of judging a work of this kind is to consider the relative amounts of space allotted to different topics. Considered in such a way, the present volume presents a somewhat queer picture. "Counseling in Student Personnel Work" occupies six pages, "Memorisation" rather less than two not particularly effective pages of a general article called "Genetic Psychology". "Experimental Psychoanalysis" and "Experimental Abnormal Psychology" receive together more than double the space allowed to "Experimental Psychology". "Porteus Maze Tests", no doubt excellent devices of their kind but after all not the only ones, get eight pages all to themselves, and "Lie Detection" has just about the same prominence as "Learning". "Rat in Animal Psychology" absorbs thirty-two pages, "Industrial Psychology" two and a half. "Semantics" (Language) runs to thirty-four pages, and "Intelligence Testing and Tests" to four. Speaking generally, problems of a pathological order receive very much more attention than anything else.

There seems a notable absence of plan, as if authors were more or less picked and then left 'to get away' with their particular pet topics. This works well enough at times, and at others gives rise to odd

results, as in a rather detailed discussion of "Climate and Human Behavior" which, among other things, observes that "The hot drought phase is the typical season for despots, dictators, communism, totalitarianism, Gestapo, pogroms, fascism and decadence in general".

The writing is very uneven, but extremely rarely distinguished. With some exceptions the factual material is correctly and concisely reported. At the same time, it is in general highly selected, with an immensely strong bias towards the writing down or omission of anything that is not American.

The editor says that this encyclopædia is intended to serve the needs of three classes of people. First, there is the expert investigator who wants to find out the facts about topics of research which lie outside his own field. Well, such a person will no doubt have a background for critical evaluation and can look after himself. It seems likely, however, that most investigators will want to go where they can get both fuller and better information. Second, there are undergraduates and graduate students who have heard things mentioned in passing, by their lecturers, and want to discover more about them. The book is of far more doubtful value for these, because most of them will lack the critical equipment needed to appraise a large bulk of its contributions. Third, there are the people who want to know what are the trends in current psychology. Whether the book adequately or clearly represents these trends and whether in any event the trends can be properly understood without a much wider setting than can be attempted in a large series of short and shortish articles, many of them extremely restricted in scope, could obviously be a subject of long debate. One thing, however, seems plain. The last seven years have made a lot of difference to psychology, but this is far from obvious so far as the effort of the present volume is concerned.

For trends alone, a smaller book, with longer, better informed and much more international surveys of a few outstanding developments, would be preferable. For a genuine psychological encyclopædia—if this is required—a very much larger volume or succession of volumes could alone fill the bill.

F. C. Bartlett

UNIFICATION OF ALGEBRA

College Algebra

By Prof. A. Adrian Albert. Pp. xii+278. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 14*s*.

IN one sense, it is somewhat surprising to find how little progress has been made, during the past fifty or sixty years prior to 1939, in the presentation and content of many subjects taught in schools and colleges. In some directions there has been a considerable advance, notably in experimental science, but in mathematics the forward movement has been much slower. Our methods and subject-matter seem to be securely tied up in the bonds of tradition. Yet, all the time, a great and evolutionary force has been quietly at work; this has eventually inspired the necessity for a new outlook and a corresponding change in the *modus operandi*. The Second World War has contributed considerably to this onward sweep, for it has revealed in no unmistakable manner how far behind we are. It must not be forgotten that it took a long time to replace Euclid by modern geometry, as well as to break down the artificial barriers erected by tradition between the various compartments into which mathematics was originally divided. It is, for example, not so long ago that the student of arithmetic and pure geometry was denied any application of algebra to those subjects. Happily, those days have gradually passed away, yet much remains to be done. Only recently, the Mathematical Association devoted much time to a discussion of reforms in the school certificate examinations. As a result, it advocated considerable revision in the syllabuses prescribed by the examining authorities—less formal algebra and geometry, and a closer co-ordination between geometry and trigonometry.

But the evolutionary spirit has also penetrated the subject-matter itself. Newer conceptions are demanded which will not only develop a more coherent unity in mathematics generally, but also in the compartments themselves. In the case of algebra, for example, it asks: Is algebra, as taught to undergraduates, regarded as a complete entity, or is it made up of a collection of seemingly unrelated topics? Prof. Albert, who is well known for his outstanding research on algebra, declares that the time is ripe for the subject to be presented as a unified whole instead of a miscellaneous collection of isolated topics; hence this new and inspiring work on "College Algebra". As he pointed out in an earlier volume entitled "Introduction to Algebraic Theories" (1940): "During recent years there has been an ever increasing interest in modern algebra, not only of students in mathematics, but also of those in physics, chemistry, psychology, economics and statistics".

"College Algebra" formulates a standard minimum of requirements which emphasize that algebra has a basic unity. The first three chapters are devoted to number systems, and include permutations and combinations, since these "involve nothing but counting". The fourth chapter deals with the purely algebraic theory of polynomials and rational functions. In Chapter 5, on identities and applications, the binomial theorem, summation formulæ and the progressions are treated in logical sequence and with great clarity. The sixth and seventh chapters are concerned with equations, both in theory and practice, while in Chapter 8 the algebraic theory of vectors and linear equations is linked up with trigonometry and analytic geometry. Finally, in the last two chapters, matrices, determinants and linear systems are discussed. It should be mentioned here that the author regards Chapter 10, devoted to matrices and quadratic forms, as a pedagogical experiment, since his personal experience has shown that the "theorems and techniques can be taught to immature students if no attempt is made to derive the results". Thus the text is presented in this form and should be useful to mathematical economists and psychologists.

As in all Prof. Albert's books on algebra, the subject-matter is arranged with consummate skill and written with great clearness, with the laudable desire of providing a sound foundation upon which to build an intelligent course in the calculus. The order of treatment may seem a little unusual at first, but the book tends to open a new epoch in the presentation of algebra as a new and rigorous approach to the subject, and notably in the emphasis placed upon knitting together the various topics into a fundamental unity.

It would be both interesting and progressive to see a school algebra fashioned upon similar principles.

F. G. W. Brown

Textile Design and Colour

Elementary Weaves and Figured Fabrics. By William Watson. Fifth edition. Pp. xii+513. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 25*s*. net.

THE author, in this edition of his book, has revised the earlier editions and added further chapters bringing his subject-matter up to date. The volume is, in consequence, more interesting and comprehensive and, because of its wider scope, more likely to have a general appeal.

In the earlier chapters, a detailed and well-illustrated description is given of all the simpler fundamental weaves requiring one warp and one weft, which makes this portion of the book particularly suitable for the young student or for those wishing to revise their knowledge of fabric structure. Herein, one finds all the structures clearly defined from plain weave, twills, satins, sateens, to bedford cords and piqués.

The second portion of the book, which describes the light and pigment theories of colour and their simple application to woven textiles, is sound, as are the chapters dealing with the simpler jacquards and the figured fabrics woven thereon. The author presents, in a lucid manner, the method by which jacquard designs are produced from the sketch, and developed through point paper drafting to the woven fabric.

But it is the latter part of the book which the more experienced reader will find valuable. To anyone connected with the textile industry, the glossaries of yarns, weaves and fabrics are most useful as sources of reference. The chapter on the manufacture of rayon, outlining as it does the processes for producing the different types, and the section on recent developments in fibres and yarns are particularly interesting, especially when dealing with the characteristics and definitions of the new synthetic yarns. The subject of cloth firmness, with the necessary calculations for finding the ideal cloth particulars, or any required changes either in sett or counts of yarn, will be found useful to both student and manufacturer alike.

In fact, this volume is a good, sound text-book and is recommended to those requiring a thorough knowledge of the simpler weaves and of the yarns necessary for building up their structures.

A. M. LATHAM

Differential and Integral Calculus

By Prof. Ross R. Middlemiss. Second edition. Pp. viii + 497. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 16*s*. 6*d*.

THE first edition of this very useful book was briefly reviewed in *Nature* of July 19, 1941. In this new edition, the general plan has been retained and such modifications made in the text as experience has rendered necessary. These changes have involved the rewriting of many sections and several entire chapters. A serious attempt has been made to improve the rigour without adding to the difficulty of the text. For example, the treatment of partial derivatives has been practically recast in order to place emphasis on physical rather than purely geometrical aspects, while the chapter on multiple integrals has been revised and expanded to include spherical as well as cylindrical co-ordinates.

A commendable change in the sections devoted to the applications of the definite integral is the substitution of Duhamel's principle by simpler and, in some cases, by more valid methods. A drastic revision of the chapter on infinite series has been made, which now includes a useful theorem for estimating the comparative value of the remainder after k terms.

Finally, most of the problems in the original edition have been replaced and the total number increased. Curiously, answers are only provided to those exercises which bear odd numbers. As in the earlier edition, the text is clearly printed and excellently illustrated by many well-drawn figures.

Undoubtedly, the changes made by the author tend to improve the book, and no reader should have any difficulty in gaining a thorough understanding of the fundamental principles of the calculus.

Acoustics for Architects

By Dr. E. G. Richardson. Pp. 90. (London: Edward Arnold and Co., 1946.) 5*s*. net.

AS the title implies, this small book is specially written for the 'general practitioner' in architecture, who merely requires, according to the author, a statement of the fundamental acoustic principles, and help in applying them in practice. It is not intended for the physicist, who would, of course, find it far from satisfying.

In the first chapter, the author gives just sufficient information concerning the characteristics of sound to enable him to make the rest of the book fully intelligible to the reader, and he does this very well. Further, he emphasizes the importance to the architect of securing uniform acoustic conditions in a hall over the important range of frequency which lies between 100 and 5,000 vibrations per second.

A very useful second chapter is devoted to a historical survey of the study of the acoustics of buildings, to help the student to understand the problems which arise in applying the laws of sound to architecture. From this point the author develops his theme in a logical and clear way, and the last chapter gives a résumé of the principles of acoustics in the form of suggestions for planning various types of auditorium for the best conditions of listening.

The book, which is produced under war economy conditions, is well written, and what diagrams are included are straightforward and understandable.

Vie et transmutations des atomes

Par Jean Thibaud. (Sciences d'aujourd'hui.) Deuxième édition revisée. Pp. 290+24 plates. (Paris: Albin Michel, 1942.) 86 francs.

SINCE 1942, when this revised edition of an older book of 1937 appeared, relatively little has been published on nuclear physics, except in connexion with fission. This exceedingly lucid account of the subject, which has been received recently, probably remains one of the best of the few available texts of its kind. Emphasis is primarily on the experimental side, but the references to nuclear theory, and to fundamental matters of a more general character, are apt and suggestive. The plates constitute a most attractive feature. There are twenty-four of them, each beautifully printed on a separate page. A number are copied from other publications, but some appear to be original. Altogether they provide, among other things, a vivid record of the appearance of a nuclear physics laboratory and of the apparatus used in it, which is possibly of more than passing interest.

THE MAKING OF THE MISSING CHEMICAL ELEMENTS*

By Prof. F. A. PANETH
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ALMOST five years ago, in a lecture to the Institute of Chemistry in London, the success that radioactive methods had achieved in the task of completing the Periodic System was described[1]. In the table given, the place of element 87 was filled by the symbol of a newly discovered branch product in the actinium series; but in the places of elements 43, 61, 85 and 93 no symbols were inserted, although, as explained in some detail, atoms of all these four elements had been artificially produced.

This denial of full citizenship to artificial elements seemed justified in those days. They had been produced in invisible amounts only, and they were unstable and usually not present on the earth; whereas in the case of all the natural elements, we could be sure that, even if they belonged to the radioactive families and were only represented by fairly short-lived isotopes, very considerable quantities always existed. (For example, the laws of radioactive equilibrium ensure the presence in the upper 60 km. of the earth's crust of more than 10,000 tons of polonium.) The limited importance attributed until a few years ago to the artificially produced elements was reflected also by the absence of any names suggested for them.

To-day the situation is very different. In the 1942 lecture the cyclotron was called "the most efficient instrument for atomic transmutation". Now this title goes to the uranium pile, with its largely superior output of neutrons. With its help many pounds of an artificial element with atomic number 94 have been produced which, on account of its half-life of more than 20,000 years, will be present on the earth for a long time to come. (For theoretical reasons we must expect a minute proportion of element 94 always to accompany natural uranium.) Although its manufacture was difficult, it would be a harder problem still to destroy the element; even if exploded as a bomb, only a fraction of the material comes to a premature end. Moreover, the availability of any desired quantity of element 94 opens the way to the production of visible amounts of elements still higher in the Periodic System. Finally, the uranium pile has given us the means of creating lighter elements in bulk too; among the very products of uranium fission are many new isotopes not only of well-known elements, but also of the missing elements 43 and 61, which can thus be obtained in a far greater quantity than by any previous method. The chemistry of some of the newly created elements is already known as well as, or better than, that of some of the less important ones which were discovered in Nature many decades ago, and their practical application is at least a possibility.

In these circumstances, there seems to be no doubt that the time has come for the systematizing chemist no longer to discriminate between natural and artificial elements, but to pay equal attention to the study of both and, in the tables of the Periodic System, to insert everywhere the appropriate symbols. In this latter attempt we are, however, confronted with the difficulty that there is at the moment no complete agreement about the relative merits of the various claims to the discovery, or manufacture, of new elements. It is to be hoped that this question will be carefully discussed at some future meeting of a committee invested with international authority; pending that, I can give merely my personal views. However, an exchange of letters with several scientific workers interested in these questions has convinced me that most of them have come to the same, or very similar, conclusions.

In accepting names and symbols for the elements 43, 61, 85, 87, 93, 94, 95 and 96, I think chemists ought to be guided by the following rules. (1) The right to name an element should go to the first to give definite proof of the existence of one of its isotopes. (2) In deciding the priority of the discovery, there should be no discrimination between naturally occurring and artificially produced isotopes. (3) If a claim to such a discovery has been accepted in the past, but is refuted by later research, the name given should be deleted and replaced by one chosen by the real discoverer.

To state the last rule in so many words would seem unnecessary, if it were not that in at least two cases the general practice violates it[2]. The names 'masurium' and 'illinium' are so firmly rooted in text-books and tables that recent work on artificial isotopes of the elements 43 and 61 is sometimes referred to as the production of species of masurium and illinium, while the artificial isotopes actually were the first representatives of the hitherto missing chemical elements. Without going into details of the alleged discoveries, it seems necessary to say that the slowness of chemists in taking the obvious action of abandoning the suggested names is due to the failure of the claimants to withdraw their statements, although during years of intensive effort they had been unable to substantiate them. In the case of masurium, W. Noddack even went so far, five years after the announcement of the discovery, as to complain to the convener of a chemical meeting in Königsberg for not having invited him to speak on this element, as the geographical neighbourhood of Masuren would have made this specially appropriate and he would have been in a position to disclose the whole chemistry of masurium; but no communication has ever appeared on this work. During the War, W. Noddack was appointed professor of inorganic chemistry in Strasbourg by the occupying power; when in 1945 the French chemists returned, they found the symbol Ma painted on the wall of the main chemistry lecture theatre in a large representation of the Periodic System. (Private communication from Dr. J. Guéron.)

Actually, element 43 was first produced by Perrier and Segrè in 1937 by bombarding in the cyclotron element 42, molybdenum, with deuterons or with neutrons[3]. This work was extended by Seaborg and Segrè[4]. Further details may be found in my lecture of 1942[1]. As to element 61, I mentioned in that lecture the work of two research teams, Law, Kurbatov, Pool and Quill at Ohio State University[5], and Wu

* Substance of a lecture delivered before the Royal Institute of Chemistry in Leeds on October 29, 1946.

and Segrè at the University of California[6]. It is most probable that both had isotopes of element 61 under investigation; but the difficulties of ascribing the various, not very strong, activities to definite atomic species were very great in those days, when cyclotron bombardment was the only means of producing them.

Now we are able to direct attention to an investigation on element 61 during the War by research workers engaged in the study of the radioactive fission products of the uranium pile. Speaking last April on the occasion of a symposium on nuclear chemistry at Atlantic City (New Jersey), Prof. Charles D. Coryell, of the Massachusetts Institute of Technology, then at the Clinton Laboratories, Oak Ridge, Tennessee, revealed that among the many scientifically important results obtained by workers on the project—he mentioned in this connexion especially N. E. Ballou, L. E. Glendenin, J. A. Marinsky, E. R. Tompkins and G. W. Parker—was the clear identification of an isotope of element 61, with a half-life of 3·7 years. It is formed by the β-disintegration of a neodymium isotope with half-life of 11 days, and decays into a stable samarium isotope. It is only a question of time when milligrams of this element, unknown in Nature, will be available for study.

The next of the missing elements, 85, was manufactured by Corson, Mackenzie and Segrè in 1940, and its chemical character studied[7]. The great significance of this work has been emphasized before[1]. We have to add now the interesting fact that about two years later Karlik and Bernert[8], in the Vienna Institute for Radium Research, obtained strong evidence that in all three natural radioactive series, isotopes of element 85 occur; they discovered new groups of α-rays, the energies of which agree very well with those to be expected for atoms of element 85 with mass numbers 218, 216 and 215; such isotopes could be formed in the radium, thorium and actinium series in the percentages observed, if either the *A*-members or the emanations showed a small tendency to β-disintegration in addition to their well-known α-decay. The experiments do not yet allow us to distinguish between these possibilities; whereas, therefore, the mechanism of the formation of these new branch products is still uncertain, there seems no doubt that the Misses Karlik and Bernert have to be credited with the proof of the existence of natural isotopes of element 85. Former claims were open to grave objections and were experimentally disproved by very careful work by the Vienna physicists[9].

Nothing new can be said about the undisputed discovery, reported earlier[1], of element 87 in the form of a natural isotope, actinium K, by Mlle. Perey[10].

The most spectacular development has taken place in the region of the trans-uranium elements. As is well known, this work had a direct bearing on the production of one type of atomic bomb and was secret during the War; but to-day a sufficient amount of information has been released to permit an appreciation of the scientific value of the new discoveries[11].

If a neutron is captured by a uranium atom $^{238}_{92}U$, a new uranium isotope $^{239}_{92}U$ is formed which emits β-rays and changes, with a half-life of 23 min., into an element with a β-activity of half-life 2·3 days. The fact that this β-radiation, which had been observed before, belonged to the element 93 was proved by McMillan and Abelson[12] early in 1940 with the help of chemical and physical experiments; they are, therefore, to be considered as the discoverers of the first trans-uranium element. As its name they proposed neptunium (Np), from Neptune, the first trans-Uranus planet. Owing to its short life-time, invisible quantities only of $^{239}_{93}Np$ are available. Later, however, A. C. Wahl and G. T. Seaborg found another isotope of neptunium, of mass number 237, which is an α-emitter with a half-life of $2{\cdot}25 \times 10^6$ years; it is formed by the β-decay of a uranium isotope 237 (half-life 7 days), a substance which can be produced by bombarding $^{238}_{92}U$ with fast neutrons either in the cyclotron or, better, in the uranium pile. Of this long-lived neptunium species, hundreds of milligrams have already been obtained in the form of pure chemical compounds. A thorough investigation showed that the chemistry of neptunium closely resembles that of uranium; it can occur in the same valency states III, IV, V and VI, of which the lower ones are, however, more stable than the corresponding ones in uranium.

It has already been mentioned that $^{239}_{93}Np$ emits β-rays. Consequently, the daughter element occupies place 94 in the Periodic Table; its half-life is about $2{\cdot}4 \times 10^4$ years, and it decays with α-radiation, thus being the parent of $^{235}_{92}U$, the well-known actino-uranium which forms 0·7 per cent of the naturally occurring element uranium. This isotope of element 94 was found by J. W. Kennedy, G. T. Seaborg, E. Segrè and A. C. Wahl[13] early in 1941; it was, however, not the first discovered; already in the preceding year G. T. Seaborg, E. M. McMillan, A. C. Wahl and J. W. Kennedy[14] had shown that deuteron bombardment of uranium 238 led to an isotope of neptunium of the same mass number, which is β-radiating, and thus gives rise to an isotope of element 94 with the mass number 238. This new substance emits α-rays and has a half-life of about fifty years; its disintegration product is identical with the uranium II of the natural series. Following the tradition of the naming of uranium and neptunium, the discoverers of element 94 suggested for it the name plutonium (Pu), after Pluto, the tiny outermost member of the solar family, found in 1930. The study of the properties of plutonium was at the outset very difficult owing to the invisibility of the quantities available of $^{238}_{94}Pu$; but of $^{239}_{94}Pu$, with its long life-time, one could prepare by extended cyclotron bombardment an amount sufficient for chemical investigation, albeit at the beginning only for 'ultra-microchemical' studies. Later, by the use of the neutron-capture reaction in the uranium pile, very large quantities of plutonium have been manufactured for military purposes. Its chemistry, electro-chemistry, and physical properties are very accurately known. It has been disclosed that this element, like neptunium, resembles uranium; again, we find the valencies III, IV, V and VI, valency III being more stable than in the case either of neptunium or uranium.

Since any desired amount of plutonium is now available in the laboratories engaged in the working up of the material of the uranium piles, it was only natural to try whether elements higher still in the Periodic Table could be obtained by bombarding plutonium in the cyclotron. G. T. Seaborg, R. A. James, L. O. Morgan and A. Ghiorso, in collaboration with J. G. Hamilton and his group of physicists, found that helium ions of very high energy (40 MeV.) actually produced isotopes of elements 95 and 96; not much has yet been published about their chemis-

try, but it seems that the general similarity of the trans-uranium group with uranium is maintained. This is no surprise if we remember that Bohr, so early as 1922, in his theoretical treatment of the Periodic System, predicted a kind of 'rare earths group' in this part of the table, beginning at, or shortly after, uranium[15]. Following this analogy, the discoverers of elements 95 and 96 propose the names 'americium' (Am) and 'curium' (Cm), to emphasize the probable similarity of their electronic structure with their lower homologues europium and gadolinium. (Obviously there were no names of further planets available; should such ever be discovered in the future, a leading American astronomer believes that his colleagues would follow then the chemical nomenclature[16].)

I hope I have made it clear that, in my opinion, if we observe the rules laid down above, there is scarcely room for any doubt as to who should be entitled to name the eight newly discovered chemical elements. For the elements 94–96 the question seems already settled, and the names neptunium, plutonium, americium and curium will most likely be generally accepted. As to element 87, a few more words are necessary. The name actinium K, as chosen by Mlle. Perey, is obviously only suitable for the particular isotope she discovered; the element, which may comprise various isotopes, should have a name not so closely linked with the special branch product of the actinium series. (Compare the sense in which 'polonium', which subsumes all the isotopes of element 84, is distinct from 'radium F', which is only the most important of the isotopes, and the first discovered.) As a result of correspondence with Mlle. Perey, I can state that she shares this view and proposes as the name for element 85 'francium' (symbol Fr).

So far no names for elements 43, 61 and 85 have officially been put forward by their discoverers, Perrier and Segrè, Coryell and his group, and Corson, Mackenzie and Segrè, respectively. Every chemist concerned with the task of teaching systematic inorganic chemistry and of keeping his table of the Periodic System up to date will be grateful if they will publish soon the names which they consider suitable. [See p. 24 of this issue of *Nature*.]

[1] *Nature*, **149**, 565 (1942).

[2] Similar mistakes have been perpetuated in the older nomenclature. For example, the last of the rare earths should not be called lutetium (Lu), but cassiopeium (Cp); about the priority of Auer v. Welsbach's claim see F. A. Paneth, *Ergeb. exak. Naturwiss.*, **2**, 168 (1923).

[3] Perrier, C., and Segrè, E., *Rend. Lincei*, **25**, 723 (1937); *J. Chem. Phys.*, **5**, 712 (1937).

[4] Seaborg, G. T., and Segrè, E., *Phys. Rev.*, **55**, 808 (1939); Segrè, E., *Nature*, **143**, 460 (1939). See also Segrè, E., and Wu, C. S., *Phys. Rev.*, **57**, 552 (1940).

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[6] Wu, C. S., and Segrè, E., *Phys. Rev.*, **61**, 203 (1942).

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[8] Karlik, B., and Bernert, T., *Z. Phys.*, **123**, 51 (1944).

[9] Karlik, B., and Bernert, T., *Naturwiss.*, **30**, 685 (1942); *Sitz. Wien. Acad.*, **151**, 255 (1942).

[10] Perey, M., *J. Phys. et le Radium*, **10**, 435 (1939).

[11] See especially G. T. Seaborg, *Chem. and Engin. News Edit.*, **24**, 1192 (1946).

[12] McMillan, E. M., and Abelson, P. H., *Phys. Rev.*, **57**, 1185 (1940).

[13] Kennedy, J. W., Seaborg, G. T., Segrè, E., and Wahl, A. C., *Phys. Rev.*, **70**, 555 (1946).

[14] Seaborg, G. T., McMillan, E. M., Wahl, A. C., and Kennedy, J. W., *Phys. Rev.*, **69**, 366 (1946).

[15] Bohr, N., "Spektren und Atombau" (Vieweg, 1922), 133.

[16] Shapley, H., in "One World or None" (McGraw-Hill Book Co., 1946), 10.

POPULATION STUDIES IN FISHERIES BIOLOGY

By G. L. KESTEVEN

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THE analysis of populations of fish, chiefly in relation to age composition, has developed greatly since Peterson[1] described his method of dissecting length–frequency curves. Such analysis makes use of the ability to identify the age of fish from certain structural features of scales, otoliths and similar structures, and is associated with the problem of measuring the rate of growth. For effective application, this work requires the employment of vigorous sampling techniques related to commercial and experimental operations, as described by Fridrickson[2], Hodgson[3] and Sette[4,5]. Analyses of this kind have been employed for the following purposes: (*a*) to compare stocks of different regions[6]; (*b*) to compare stocks at different times[7]; (*c*) to assess mortality-rates[8]. The first two have been employed chiefly in relation to the study of 'condition' of fisheries in connexion with the possibility of depletion. The latter use was developed by H. Thompson[9] when, in working on haddock, he presented a technique for measuring recruitment into the fishable stock and for subsequent assessment of the effect upon the stocks of the strength of successive broods.

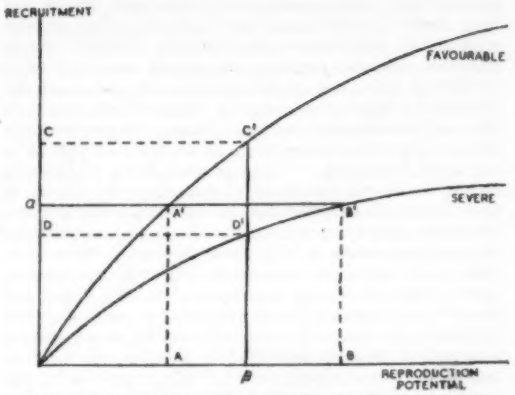
It does not appear to have been appreciated that the analysis of the stock can have greater meaning than hitherto has been seen in it. Its value is not so much for the primary result of revealing the relative numbers of various size, age, sex, gonad condition, feeding and other biological groups which characterize the population, nor even for the indication which it might yield of the possibility of depletion: its chief significance is as a means of measuring the dynamic properties of the population, interaction of which with the environment determines the compositional characteristics. The main properties are the potentials of growth (weight increase) and reproduction, and despite the work of Chapman[9] in presenting the original concepts in this work, the significance of these potentials has been neglected.

It has been argued[10] that no necessary relationship exists between the number of spawners of a particular stock in a particular year and the number of young fish eventually recruited to the fishery. There exists here some ground for misunderstanding: the vicissitudes to be suffered by spawners, eggs, larvæ, post-larvæ and young fish are such that the argument as to numerical relationship between any pair of the above links in the reproductive chain has little or no validity as between any other pair; yet this does not make it impossible to measure the successive relationships, in conjunction with observations upon the environment. The necessary analysis of these components has begun already in the work on plaice[11] and haddock[12], in which the strength of the spawning population has been estimated from egg abundance, and the dispersal and mortality of eggs have been measured. Further work on haddock[13] has attempted analysis of the relationship between strength of the mature population and survival of broods. The technical difficulties of this type of work, particularly in planktology, are not belittled; but it is held that they have already been shown to be not insuperable.

It is suggested that a first purpose of stock analysis is to yield a preliminary estimate of the likely abundance of eggs to be produced by the population, that is, the potential fecundity of the spawning population. From that point observational work should provide an estimate of the *effective* egg production, and eventually of the survival of eggs, larvæ and young fish. Theoretically the sequence should thus lead to an estimate of recruitment, the accuracy of which could be compared with the observed strength of the recruit class. Continuance of such work over a number of years would undoubtedly yield a fairly precise correlation between the three elements: (*a*) the spawning population; (*b*) environmental conditions; (*c*) recruitment. With refinement of technique and extension of sampling, such work should convert the preliminary relative estimates of (*a*) and (*c*) into reliably absolute ones, and after sufficient years the actual strength of each age (or other) group will be known from having been observed since its spawning. A schematic representation of these relationships is given in the accompanying illustration. The fact that the actual relationship between reproduction potential and recruitment might be quite other than the curvilinear one shown here does not detract from the generality of the argument presented. It is suggested that for any level of reproduction potential, say, on the ordinate, there exists a range of levels of recruitment between *C* and *D* on the abscissa marked off by the projection from the points *C′* and *D′* on the curves of relationship which delimit extremely favourable and extremely unfavourable environmental conditions. Such limits as these could be marked off in a scatter diagram; but it is recognized that the accumulation of sufficient material for this method would be a matter of considerable difficulty, and it is suggested as alternative that quantitative expression of environmental favourability should be attempted and the limits suggested in the illustration defined thereby. On the other hand, the relative position on a diagram such as this of point relationships between estimated reproduction potential and observed recruitment should indicate relative favourability of the environment and assist in assessing the significance of various environmental factors.

The significance of these suggestions in the general theory of fisheries exploitation is discussed below.

Growth curves measuring linear and mass increases have been prepared for very many species of fish. Since it is possible to measure the amount of growth which a fish of a given age is capable of accomplishing in a given period, it should also be possible to predict the amount of growth which numbers of fish of diverse ages should be able to accomplish in a similar period. Such growth would, of course, be dependent upon the amount of food available relative to the requirements of the population, and upon other environmental factors. Some experimental research has been carried out on the nutritional requirements of fish[14]; but it is not surprising, remembering the difficulties of experimenting with fish, that this work has not yet got very far. The observational work on conditions of growth of fish is also inadequate, particularly in connexion with the effect of population densities upon growth. There has been much controversy, for example, over the question of whether over-crowding reduces the growth-rate, and whether the converse, depopulation, is likely to lead to increase. However, observation of stock composition, estimates of related growth potential, and subsequent



THEORETICAL RELATIONSHIP BETWEEN RECRUITMENT AND REPRODUCTION POTENTIAL

measurement of growth achieved should permit a correlation between growth potential and the environment, similar to that proposed between reproductive potential and the environment, and allow a useful prediction of the amount of increase in mass which may be expected from the population.

As offset to the increase in numbers (reproduction) and in mass (growth), natural and fishing mortalities operate to reduce the population. Many mathematical analyses have been made[15] of the relationships between hypothetical values of the terms fishing mortality, natural mortality, growth and reproduction; but it has yet to happen that anyone should prepare a formula which has validity over a wider range of years than that for which the formula was prepared. The formulæ so far presented to describe fish populations relate chiefly to the consequences of changes in the intensity of fishing operations. It is not, I believe, unfair to say that none of them has attempted to evaluate the actual properties of any fish population (even theoretically), or to conceive the measurement of the interaction of population and environmental properties, with the view of determining the basic reasons for mean levels of abundance and year-to-year changes of these levels. In point of fact, it has been a matter of some concern that the relationship between the fisheries biologist on one hand and the hydrological and planktological team on the other has at most times been somewhat tenuous. The results of the work of the latter group have been applied in biological analysis in a somewhat haphazard fashion: the boundaries of major water masses have been recognized and correlated with certain biological phenomena[16,17], and some correlations between occurrences of fish and wind[18] and phytoplankton[19] have been demonstrated; but these fall far short of the degree of integration which must be achieved to bring this science to the level of precision of which it is capable.

Of the formulations of the modern theory of fishing, Russel's[20] is probably simplest. According to this

$$S_2 = S_1 + (A + G) - (C + M),$$

where S_1 and S_2 represent the stock in successive years, A the recruitment, G growth, A and M catch and mortality. It will be recognized that this constitutes a useful symbolism, facilitating discussion, but is not an analytical weapon. Subsequent formu-

lations have been presented by Graham[21], Thompson and Bell[22] and Thompson[23], and these have some continuity with the work of Baranov[24,25]. These theories have been mainly concerned with the effect of fishing upon the stocks, and have approached the matter by way of attempted theoretical equations for the gross elements of the system; they have been based upon the recognition of a stock of fish as a self-reproductive system, the growth of which is demonstrably a simple exponential function. However, it has been necessary to assume values for the various elements, and by test to ascertain which combination of rates best fitted the observed conditions. Moreover, this work has been concerned with the population as a whole, and reproduction-rates, etc., employed have been assumed sum expressed rates for the population: that is to say, the technique presents a theoretical description of the population, but no analysis. One consequence of this approach to the population as an implied homogeneous whole has been a fallacy in respect of the significance of the point of inflexion of the sigmoid curve describing the growth of the population. Graham[26] has argued that since the rate of growth in an organism, or population, is greatest at the point of inflexion of the sigmoid curve which describes that growth, then the rate of growth at this point represents the optimum which may be expected from each population, and the catch which can be taken from a fish population at that point will prove to be the optimum. It is pointed out, however, that at the point of inflexion the high rate of growth represents the highest excess of reproduction over mortality (that is, of individuals of which the population under consideration is composed, whether cells or organisms); but actually reproduction will be greatest at some later point. Since a post-reproductive group has not yet been demonstrated in fish, it is presumed that both reproduction and mortality will continue to mount higher with the increase in the size of population, provided such numerical increase in population strength is not solely composed of young fish, with consequent decline in average age for the population.

The relationship between recruitment, mortality and intensity of fishing has lately been submitted to more detailed mathematical analysis, especially by Ricker[27,28].

It is the intention of this paper to submit that the approach to this problem has hitherto been insufficiently balanced. Raitt[29] has referred to the intricacy of the relationships involved in relation to reproductive capacity, and the work of Baranov[24] and Herrington[12] has considered the problems of nutritional limitations upon population growth. But these fill in detail of only part of the picture of a few populations. What is required is the comprehensively detailed analysis of the population to identify all the components of the system, and to measure the factors which operate upon these components. This will yield a better measure of the consequences of fishing, both the immediate effect of proportional removal and the later consequences to population properties of these removals. Further, this work will permit a more realistic approach than has hitherto been possible to the question of determining optimum catch; that catch being defined as the quantity, from each particular population, which will ensure the fullest expression of the population's potentials of growth and reproduction. Definition in this form is necessary since the precise relation between the various terms is as yet unknown. I have recently[30] given a general discussion of the planning of this work.

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RECENT ADVANCES IN CANCER RESEARCH*

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EXPERIMENTAL cancer research is less than fifty years old, even younger than bacteriology; a few of those who began it are still active. It started when the rewards of the close observational study of human cancer had become small. Then for the first time medical scientists paid attention to the fact that animals have tumours too—a fact known for some while. With the demonstration that these growths are true neoplasms (new growths) and the transfer of some of them from host to host, things got under way. At first hopes ran high that the cause of cancer would soon be found; but then it became clear that the animal tumours maintained by transplantation carried the secret along with them. Nothing could be procured from the tumour cells which would cause other growths, and anything killing them, in even the most subtle way, brought the neoplastic process to an end. Furthermore, the transplanted tumours called forth no resistance of

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practical significance. The cultivation of cancer cells *in vitro*, though occupying many workers, contributed no deep-going enlightenment, and until 1915, when tumours were purposely induced by means of tar, workers were unable to get at the conditions determining the occurrence of neoplasms. Until then observations on the 'precancerous states' of man had been the sole reliance of the investigator, since the spontaneous growths of animals had progressed too far when first encountered to be informing. Now at last the conditions leading to cancer could be got at experimentally.

This paper is concerned with recent advances. Perhaps the biggest step forward of the last few years has been the comprehension, gained very gradually during the busy production of tumours by experimental means, that cancer is not a separate neoplastic entity, standing by itself, but merely one among the immense group of the true neoplasms, all these exemplifying the same general principles however much they differ in cellular composition. Every worker knows that carcinogens call forth growths of all the main categories dealt with in the text-books on human neoplasms. A single chemical carcinogen may elicit the entire gamut of the tumours, the precise kinds which occur in any experiment depending upon the kinds of cells on which the agent is brought to bear; and the most widely different carcinogens may give rise to tumours of identical sort. Not only this, but they also call forth the leukæmias as well, and almost insensibly these latter have come to be acknowledged as within the neoplastic fold. Every now and then, indeed, leukæmias are met with or induced in animals, which are made up of cells capable of giving rise to local tumours if injected into the connective tissue instead of into the blood. The investigator who tackles the cancer problem really tackles the tumour problem as a whole, and he can hope that by studying one growth he may learn something about them all. From here on the words 'cancer' and 'tumour' will often be used interchangeably.

Long before the first tumour was induced in an animal, physicians were well aware that there are agents in the human environment which are capable of giving rise to neoplasms. But nobody had any conception of how many there are, or can be in the future—for chemists are now synthesizing new ones. Now we know them in bewildering variety, and must expect to encounter them more and more in the future as new physical and chemical processes of unplumbed capabilities are pressed into industrial service. We literally spend our lives among them—the very sunlight is carcinogenic—and the only reason any of us go free from cancer is because the action of most carcinogens (for that is still the word used) is episodic or weak. Two British workers, Prof. E. L. and Mrs. Kennaway, have lately found, on scrutinizing English statistics, that cancers of the skin, mouth, throat, œsophagus, and stomach, all the way to the pylorus, are more frequent the lower one looks down the social scale. Evidently the skin of poor people is more likely to be injured in ways that may bring on cancer than that of those who are rich, and perhaps what they eat and drink is more likely to contain carcinogens.

A far more difficult problem than the environmental carcinogens—since these can be warded off in proportion as we get to know them—is that of carcinogenic agents arising within the body. There are strong reasons for supposing that often they do so. Some years ago the fact was brought out that tar produced by the heating of human skin would give rise to cancers when painted on the backs of mice. Of course, this did not justify the conclusion that human skin elaborates tar: one might almost as easily suppose that because the body contains hydrogen, oxygen, and nitrogen, it produces fuming nitric acid. In the last few years the discovery has been made that extracts of some diseased human tissues are capable of producing tumours in animals. It might be argued that the chemical procedures employed in obtaining the extracts have resulted in the production of substances not existing under natural conditions. But control extracts made in the same way from the normal tissues seldom have a carcinogenic action. As already stated, it is not the presence of a carcinogen, but its presence in effective quantity, which determines whether a tumour will arise. The subject of endogenous carcinogens (substances formed within the organism and capable of producing tumours) is one of the pressing themes of the present day.

For some while it has been known that certain normal substances, namely, hormones, may give rise to tumours. These substances are not themselves carcinogenic, they do not themselves cause normal cells to be tumour cells, but they bring the tissues they act upon into such a disordered and excited state that neoplastic changes take place for reasons unknown. Nobody knows what kinds of tumours they may not give rise to next in animals if administered in sufficient amount, and the present uncertainty in this matter deserves stress because the œstrogens are the best studied of the hormones. A vast amount of new knowledge in relation to cancer waits upon further tests of this class of substances.

The more closely one looks into how 'spontaneous' tumours, so called, come into existence, the more clearly does one perceive that often they are the outcome of many influences and circumstances working together or consecutively, often through years. Even the smallest details in the previous history of cancer patients may prove vital for other human beings, as giving hints as to where the chain of determining factors can be broken which leads on to the disease. Too much pains cannot be spent in eliciting such case-histories. My own belief is that eventually there will be specialists in every cancer hospital whose main aim and ambition will be to learn precisely how each patient's tumour has come about.

For nearly seventy-five years medical men have been aware that cancers often arise at sites of chronic disturbance, yet mere chronic inflammation is not enough of itself to cause them. Some special influence there is which precipitates the neoplastic change. Some workers, notably Prof. A. Haddow, have concluded that the cells become neoplastic while they are faring badly, and that the chemical carcinogens act through the depression of cellular activities that they bring about. Certain it is that injection of some of these substances causes transplanted tumours to grow more slowly than in control animals. Just before the War, a German surgeon, led on by this finding, actually painted human cancers of the skin with a powerful carcinogenic hydrocarbon, heedless of whether it induced other growths later on. He reported that the tumours disappeared, and we will doubtless never know what happened later. Haddow himself has synthesized numerous hydrocarbons nearly related chemically to those of carcinogenic sort, in an effort to find some which would check established tumours while giving rise to none on their

own account. His results in animals are encouraging to further work, and he has now begun to make clinical trials on inoperable cases. Laboratory observations made in the United States during the War on the effects of the 'nitrogen mustards' in retarding cell activity have led to the treatment with them of lymphoid tumours and leukæmia in human beings. There cannot be too many well-reasoned efforts such as these.

What can the cause of tumours be, the actuating cause which keeps cells in the neoplastic state? One favourite idea was abandoned during the first years of experimentation with carcinogenic agents; the idea that cells run amuck, forming tumours because of a relaxation of some governing influence of the body which had kept them in order previously and doing what they should. The fact that tumour cells are no mere ordinary cells which have seized an opportunity to develop in a haphazard fashion is the basis for the present-day search for some distinguishing chemical trait of the neoplastic cell. Already remarkable differences have been discovered, and some day one that is crucial may be found.

All medical men realize that most of the agents which are highly effective in producing tumours, the roentgen ray and Bilharzia ova for example, cannot possibly be the real causes for these growths. Their part is played when they have produced neoplastic change; the tumour goes on just as a fire goes on which has been kindled in any one of a myriad ways. The fact that certain hydrocarbons have been found capable of inducing tumours has led workers to ask whether substances having similar effects may not be continually elaborated within neoplastic cells and maintain them in their pathological state. Even if this is not the case, a knowledge of precisely what the synthetic carcinogens do to cells may prove broadly enlightening. Chemists are concerning themselves with these possibilities, trying to learn precisely what radical, or bond, or configuration of the carcinogenic molecule is associated with its singular effect.

New opportunities have lately been provided for studies on tumour causation through a feat of the geneticists. Strains of animals have been procured with striking liabilities to spontaneous tumours of one sort or another and equally remarkable freedoms from such growths. A high percentage of the animals of certain breeds, in some instances every animal, may develop lung tumours or liver tumours or leukæmia after they grow up, or every ageing female may have mammary cancer; while other strains almost or never have growths of the sorts mentioned. And behind the primary tumour liabilities there may be secondary ones; an animal escaping the mammary tumour which kills most individuals of its strain may be prone to leukæmia later on.

What are the reasons for this state of affairs? At first it was assumed that the tumour tendencies are passed on through the chromosomes, that they are hereditary; and then workers in Holland and at Bar Harbor in Maine, studying hybrids between mice of strains having marked and slight liabilities respectively to mammary cancer, simultaneously found that the tendency to such tumours is handed down through the mother. There followed a startling discovery by Dr. J. J. Bittner, one of the Bar Harbor group. He took new-born mice away from mother mice of strains liable to mammary cancer, had them suckled by females devoid of this liability, and found that thus he had rescued them from having the disease in later life. Also, by carrying out the experiment in the opposite direction, the tendency to mammary cancer could be conferred upon mice of strains not having it ordinarily. In mice with the tendency to mammary cancer something is passed along from one generation to the next in the mother's milk—the 'milk factor' as it is now called. A single suckling after birth is enough to confer the tendency to cancer on not only the young nursing animal itself but also its descendants as well. *Per contra*, whole races of mice can be rescued from having mammary cancer by preventing the passage of the milk factor to the individuals from which they have descended.

The milk factor does not produce its effect at once. It reaches the mammary tissue from the gut, increasing in quantity as the glands develop, and one adenocarcinoma or several make their appearance in the breasts of the mice as they grow old, sometimes in every animal. Yet nothing can be obtained from the mammary tissue or from the cancers which will cause such growths directly on injection into other individuals, only the milk factor, though this in great amount. One-millionth of a gram of mammary tissue yields enough of it, on extraction, to confer the tendency to mammary cancer on an endless series of animals. A great deal has now been found out about the factor, and everything puts it in the category of the viruses save the fact that it does not induce disease directly. The most reasonable explanation for the way it works is that it is a harmless virus, flourishing and increasing in the mammary tissue, and liable to vary so that it becomes a tumour-producing virus when its cellular environment undergoes pathological alteration, as in the breast of mice which have grown old.

One cannot doubt that within the human species there are hidden liabilities to tumours which find individual expression now and again; but statistics show that only very rarely is the layman's fear justified that there is 'cancer in the family'. Perhaps on the analogy of the inbred, pure-strain mice, brother and sister matings of human beings during a thousand years might result in pronounced familial differences as concerns the incidence of cancer; but as matters stand we can be thankful that we are a mixed lot. Certain workers with the milk factor have lately urged that the babies of human families in which mammary cancer has occurred should be raised on the bottle; but this is to subject the child to very real dangers because of fears which are ill-grounded, as the statistical evidence demonstrates.

The existence of the milk factor has given new support to the hypothesis that tumours in general may be due to viruses. Despite many attempts during the last thirty years, no viruses directly causing neoplasms have been obtained from rat or mouse tumours—the common currency of the laboratory—though a few out-of-the-way growths have yielded them. The great majority of workers on the cancer problem see little in the idea that most tumours are due to viruses, and recent experimental evidence speaks against the assumption that agents of this sort, passed from one animal to another, can be their cause. But decisive evidence in the matter may soon be available, for much can be expected of the new techniques for visibility now being worked out. With the electron microscope, Drs. A. Claude and K. R. Porter have already been able to obtain pictures of chicken tumour viruses within the cells of the sarcomas that they cause. Caspersson in Sweden is photographing cells of many sorts with ultra-violet light of special wave-lengths,

and he has thus disclosed much that was not known concerning them.

It might be thought that we would now be possessed of a thorough knowledge of what tumours themselves are like through the diligent observations on human growths made during the last hundred years; but the very conception of what a tumour is has been proved far off the mark by a recent discovery. The long-accepted definition has been that a tumour is an autonomous new growth. But Prof. C. B. Huggin's demonstration that many prostatic cancers which have metastasized stand still or disappear after removal of the patients' testicles shows that even the cells of malignant growths, of cancers ordinarily fatal, may not be truly independent in their behaviour. The cells of these prostatic cancers have been spurred on by the male sex hormones elaborated within the testicles and responsible for the normal activities of the prostatic epithelium. When not thus urged they in some instances are unable to grow, and in others are incapable even of maintaining themselves.

The meaning of this discovery far transcends its practical application; for it means that thought and endeavour in cancer research have been led astray by the idea that tumour cells are anarchic. Medical scientists have long been aware that even the worst cancers nearly all make some attempt at the customary tasks of the body. But no one had shown that neoplastic cells making such attempts at function might also respond in line of duty to normal physiological influences such as the hormones exert. How far this principle finds expression in tumour behaviour has yet to be learnt, and how successfully it can be utilized in combating tumours. The course of events with prostatic cancer justified the expectation that many mammary cancers would regress when the influence of the female sex hormone was lessened by removal of the ovaries or by injections of testosterone. While the results with women have not been very promising thus far, the fact that cancers of the male breast yield to orchidectomy or to stilbœstrol provides encouragement, for it makes plain the existence of factors of critical importance which have still to be understood and pressed into service.

At the moment the role of the hormones in the production and behaviour of tumours occupies many of the best investigators, and scarcely a month goes by without some discovery. For example, certain transplantable testicular tumours in mice will grow only if the new hosts are given œstrogen. Lipschütz, working in Chile and following up a discovery made by Nelson, that uterine myomas appear in guinea pigs repeatedly injected with œstrogen, has now demonstrated that testosterone will prevent them from developing. Whether this has a practical bearing remains to be seen.

It is a curious fact that, while hormones play an important part in tumour production and behaviour, little has been found as yet that the vitamins do. This is not for lack of tests with them.

The dependence of some tumours on hormonal influences justifies the inference that the change of a normal cell to a tumour cell is far from meaning that a growth will arise; and direct proof on this point has for some while been available. It has been found that if the calorie intake of mice is cut down so slightly that the animals are only 5 per cent under weight, appearing fit instead of fat, carcinogenic agents induce no tumours on their skin. This is not because these agents have failed to bring about neoplastic changes; for if the animals are full-fed later, tumours start forth. The 'spontaneous' pulmonary growths to which mice of some strains are liable can also be prevented by cutting down the food. It would be worth while to know whether cancer has fallen off in the starving populations of Europe. At the moment much work is under way to learn whether modifications of the diet which involve no reduction of calories will hinder tumour growth.

But how shall the presence of hidden, incipient cancers be perceived? The hope that they may elaborate specific antigenic substances, and thus provide serological tests, goes back to the first years of immunology, and recently an antigen has been come upon; Kidd has demonstrated the existence of a distinctive antigenic substance in the Brown–Pearce rabbit carcinoma. No path has been opened as yet, though, by this discovery, for the substance has proved to be peculiar to the Brown–Pearce tumour, and serologically quite different from an antigen encountered in another kind of epidermoid carcinoma of the rabbit. On the basis of these findings one might perhaps look forward to a multitude of diagnostic blood tests, each for some tumour of special sort, but not to a single test which would help in the generality of human instances—those in which the doctor wants to know whether there is any tumour at all in his patient, its nature coming afterwards. Even the possibility of special tests is still problematic, since the production of antibodies in rabbits with the tumours just mentioned, a production necessary to serological tests, is inconstant despite the circumstance that every one of the growths themselves contains the specific antigen.

FREQUENCY-MODULATION IN BROADCASTING

FREQUENCY-MODULATION, or the technique of varying the frequency of radio waves for signalling purposes, has been known and used for many years; but it was not until Armstrong in the United States in 1936 pointed out the importance of wide-band frequency-modulation on ultra-short waves, combined with a means for noise suppression, that the practical possibilities of the system for broadcasting purposes were realized. A considerable amount of development work on frequency-modulation technique took place in the United States before the War, and a number of broadcast transmitting stations have been erected and are using the frequency band 40–50 Mc./s. (wave-lengths 6–7·5 m.). It was not possible during the War to obtain much first-hand information as to the practical results obtained in the United States; and so in view of the probable importance of the system in improving both the overall coverage and the quality of reception in broadcasting, the B.B.C. decided just before the end of the War to conduct field trials in Great Britain. A discussion of the relative merits of frequency-modulation for broadcasting purposes, and of the first results of these trials, is given in an article by H. L. Kirke in the *B.B.C. Quarterly* (vol. 1, No. 2, July 1946).

In frequency-modulation technique, the radio carrier-wave is varied in frequency by an amount depending upon the amplitude of the modulating oscillation and at the frequency of the modulation, which for sound broadcasting is within the normal

audible range. At the greatest amplitude of modulation, the change in carrier frequency is termed the deviation, and the value of this as used for broadcasting in the United States and likely to be adopted in Britain is ± 75 kc./s. In contrast with this system is that of amplitude-modulation, which is used in normal broadcasting, and in which the amplitude of the carrier is varied at the modulation frequency from zero to twice its normal unmodulated value, the frequency of the carrier wave remaining unaltered during the modulation process. Any increase of modulation amplitude beyond the above maximum value would result in distortion both at the transmitter and at the receiver. In the case of frequency-modulation, there is no precisely defined point at which distortion sets in, so that if the transmitter and receiver circuits are suitably designed, a greater range of modulation can be achieved with the frequency- than with the amplitude-modulation system.

In order to render a frequency-modulated signal audible, the receiver uses a device known as a 'discriminator', which in effect converts it into an amplitude-modulated signal, which may then be detected by any of the usual methods. Since no change in amplitude of the carrier wave is required to convey intelligence, the transmitter can be operated under constant load conditions of high efficiency; and at the receiver a limiting device can be used to make it insensitive to amplitude changes, and thus limit the effects of receiver noise and electrical interference. While it would not be worth while using frequency-modulation on medium or long waves, because the band-width would have to be restricted, this does not apply to ultra-short waves, less than 10 metres in length; and the wide-band modulation can here be used to advantage with an extended audio-frequency range and improved quality of reception.

These advantages of the frequency-modulation system for broadcasting on ultra-short waves are discussed in some detail in the article referred to above, and illustrated by tabulated results and graphs applicable to frequencies of 45 Mc./s. (6·7 m.) and 90 Mc./s. (3·3 m.). For example, the electrical interference from motor-car ignition systems, which is a serious factor in the reception of ultra-short wave broadcasting, is much less serious with frequency- than with amplitude-modulation. Incidentally, in the course of experimental observations on this point made alongside a main arterial road, it was found to be extremely rare to get any interference from military vehicles, which have suitable radio-frequency suppressors fitted. The universal fitting of suppressors to motor vehicles would therefore increase the service area of a broadcasting transmitter very considerably. While the interference tests which have so far been made indicate that, on a frequency of 90 Mc./s., the field-strength required to give satisfactory reception in the presence of a given amount of interference is only about one-third that required on 45 Mc./s., it is to be noted that the field-strength obtained on the higher frequency may be less, due to greater attenuation and screening effects. The effective range is thus about the same on the two frequencies, and in both cases the use of horizontal polarization appears to be preferable.

The propagation of ultra-short waves is not greatly affected by the nature of the ground over which the waves pass, as is the case for medium and long waves; but the shorter waves are more affected by ground contour, hills casting shadows and thereby degrading the reception conditions in valleys. Considerable advantage is obtained by placing the transmitter on high ground, with as high an aerial as possible. The meteorological conditions in the atmosphere also affect the propagation of ultra-short waves, causing them to be refracted and so to reach greater distances than would otherwise be the case. The B.B.C. has carried out surveys of field-strength on both 45 and 90 Mc./s. from transmitters located at the Alexandra Palace Television Station and at its Research Department, near Oxford. Typical results described and illustrated in the paper show the effect of ground contour and the fading that is encountered when the receiving point is at or beyond direct optical range from the transmitter.

The latter portion of Mr. Kirke's article is concerned with the planning of an ultra-short wave broadcasting service, and tables are given showing the coverage area to be expected on each of the two frequencies considered, and for four grades of service between first-class reception in an urban area to second-class reception in quiet rural surroundings. Confirmation of these calculations is being obtained by the provision of practical data on the reception of frequency-modulation in the home, in the course of special tests in which members of the staff of the B.B.C. co-operate. It will thus be realized that active consideration is being given to the possibilities of ultra-short wave broadcasting with the view of relieving the present congestion in the medium and long-wave bands, and providing a satisfactory frequency-modulation service of high quality throughout Great Britain.

SCIENTIFIC CENTENARIES IN 1947

By Engineer-Captain EDGAR C. SMITH, O.B.E., R.N.

A REVIEW of the centenaries which occur in 1947 may well begin with a footnote to Prof. W. M. Smart's address to the Royal Astronomical Society on "John Couch Adams and the Discovery of Neptune", published in *Nature* of November 9, 1946. With the publication of the facts connected with the discovery, the controversy began to subside, and at the Oxford meeting of the British Association in June 1847, Adams and Le Verrier met. The latter had been invited to England by Airy; and J. D. Forbes recorded how he dined at Prof. Powell's with a small but excellent party including Airy, Le Verrier and Adams. Afterwards Forbes went to the Observatory to see Neptune. "Fancy the interest," he wrote, "of seeing the new planet for the first time in company with its two discoverers! Of course, there could be no going to bed without seeing it, and accordingly as it rose late, I did not get back to my college till very nearly two in the morning." A month later Le Verrier was at Cambridge, and so was Otto Struve, and Murchison wrote, "Whilst walking across the quadrangle of Trinity, Leverrier on one arm and Struve on the other, we saw the Duke of Wellington coming towards us in his red gown and I at once said to the two great astronomers, 'Now, gentlemen, here is the opportunity'. Struve was overjoyed, saying it was the thing of all others he wished; but Leverrier turned on his heel and left us saying, 'Pardonnez, c'est plus fort que moi; je suis Francais'."

That Oxford meeting was memorable for another reason, for it marked the beginning of the friendship of Joule and Prof. William Thomson, afterwards Lord Kelvin. To the Physics Section, Joule gave an account of his experiments on the mechanical equivalent of heat. His previous communications had not excited much interest, and this time the same thing might have happened had not "a young man . . . risen in the Section and by his intelligent observations created a lively interest in the new theory". The young man was Thomson, then twenty-three years old; Joule was twenty-seven. In a letter to Bottomley, Thomson said "that at first he thought Joule must be wrong but as he listened he recognised that Joule had certainly a great truth and a great discovery and a most important measurement to bring forward"; about a fortnight later Joule and Thomson met in Switzerland, where Joule was spending his honeymoon.

Of the notable men of science born a century ago, there is no need to say much of Thomas Alva Edison, man of a thousand patents, who was born in Milan, Ohio, on February 11, 1847, and died at West Orange, New Jersey, on October 18, 1931; or of Alexander Graham Bell, who was born in Edinburgh on March 3, 1847, and died near Baddeck, Nova Scotia, on August 2, 1922. To them both could be applied the oft-quoted epitaph to Wren to be seen in the north transept of St. Paul's Cathedral. Bell's father, uncle, brothers and grandfather had taught the laws of speech in the Universities of Edinburgh, Dublin and London, and his own work was directly in line with theirs. Edison's forbears—colonists, farmers, merchants, men of exceptional physique, energetic and independent—had nothing to do with science, and in the boy's environment there was little to suggest that he would sit up all night poring over Faraday's writings, or become known as "the Wizard of Menlo Park".

In Edison's early days, telegraphy was the principal branch of electrical engineering, and it attracted many scientifically trained investigators. Among these was William Edward Ayrton, F.R.S. (1847–1908), inventor with John Perry of many electrical instruments and a promoter of technical education. He was president of the Institution of Electrical Engineers and of the Physical Society, and several times dean of the Central Technical College, London. The Russian electrician, Paul Jablochkoff (1847–94), was a telegraphist, and at the age of twenty-four was director of the telegraph between Moscow and Kursk. This post he gave up to work at electric lighting problems. His electric 'candles', patented in 1876, were shown in the East India Docks, London, in the following year, and in 1878 were used for lighting the Place de l'Opéra, Paris. Prof. Silliman of Yale was delighted with them, and wrote, "The effect is magnificent and at this moment there exists nothing in this city of splendid effects to compare with the magical scene. The vista is about two-thirds of a mile and the effect incomparably finer than any show of artificial illumination ever before seen." Alas! Jablochkoff's 'candles' had to give way to the lamps of Swan and Edison, and their inventor returned to Russia and apparently died in poverty. Electrical engineering was also furthered by the work of the distinguished engineer and educationist, Sir Alexander Blackie William Kennedy, F.R.S. (1847–1928). Kennedy started work in a Thamesside marine engineering shop; but at the age of twenty-seven was made professor of engineering in University College, London, where he founded the first laboratory for experimental work on an engineering scale. For twenty-five years he held his chair, and then he turned from civil and mechanical engineering to electrical engineering. His services were sought for many schemes, and he was president of both the Institution of Civil Engineers and the Institution of Mechanical Engineers—which body will in June fittingly commemorate the centenary of its foundation at Birmingham with George Stephenson as its first president.

At University College, Kennedy counted among his fellow professors another great London teacher, Sir Edwin Ray Lankester, F.R.S. (1847–1929), who held the chair of zoology from 1874 until 1890, and some time afterwards became director of the British Museum (Natural History). He was the son of Dr. Edwin Lankester, F.R.S. (1814–74), a physician, coroner and botanist, who at the time of his son's birth was secretary of the Ray Society, founded in 1844.

To these names of distinguished men whose centenaries fall this year may be added those of Thomas Andrews, F.R.S. (1847–1907), a Sheffield iron-master and an active investigator into the structure and properties of metals; William Denny (1847–87), of Dumbarton, the first private ship-builder to set up an experimental tank after the plans of his friend, William Froude; and James Ludovic Lindsay, twenty-sixth Earl of Crawford and ninth Earl of Balcarres (1847–1913), to whose munificent gift of astronomical instruments and books was mainly due the building of the fine Royal Observatory on Blackford Hill, Edinburgh.

The losses by death among men of science in 1847 do not appear to have been as numerous as they were in 1846, but geology and mineralogy were all the poorer by the passing of Alexandre Brongniart (1770–1847), long the associate of Cuvier. Brongniart was director of the porcelain factory at Sèvres and professor of mineralogy in the Museum of Natural History, Paris. With Cuvier he made many geological excursions into the country around Paris; after reviewing their joint labours, Geikie said that by their demonstration of the use of fossils for the determination of geological chronology, they deserve an honoured place among the founders of geology. Six months before Brongniart died, Mary Anning died, at the age of forty-seven. She was the daughter of a carpenter and vendor of natural curiosities of Lyme Regis; when a girl of only twelve, she found the fossil bones of an ichthyosaurus, and when twenty-one and twenty-seven respectively, discovered the first specimens in England of a plesiosaurus and a pterodactyl. She died on March 9, 1847, and fifteen years later the Geological Society erected a memorial window to her in the parish church of Lyme Regis. James M'Cullagh was the son of a small farmer, but he too made a name for himself. By intense application of his unusual powers, he rose to be professor of natural philosophy in Dublin and secretary of the Royal Irish Academy, his writings on the theory of light gaining for him in 1842 the Copley Medal of the Royal Society. Overwrought, he died by his own hand on October 24, 1847, at the age of thirty-eight. Last in this group is David Mushet (1772–1847), who died at the age of seventy-four. He is perhaps best remembered for his important discovery of the Black Band Ironstone through which many fortunes were made; but he did notable work in other directions, one authority

writing that "He found the knowledge of iron, and of the ores from which the metal is derived, wrapped in the darkness of barbarism; he evolved and brought to light the true principles of both by a series of experiments, in which the most patient investigation and untiring bodily labour were combined".

At a time when so much thought is being devoted to technical education, it is worth recalling that the earliest modern technical colleges were those founded by the French Government in the eighteenth century. One of these was the École des Ponts et Chaussées, inaugurated just two hundred years ago by the administrator, Daniel Charles Trudaine, with the famous engineer, Jean Rodolphe Perronet (1708–94), "the Telford of France", as its director. The Corps des Ponts et Chaussées had been organised in 1716 for the maintenance of the roads, bridges, canals and harbours of France; and the School was for preparing likely candidates for the Corps. "The Corps and the School," said Mr. S. B. Hamilton, "closely associated, formed a professional body of men specializing in civil engineering, as distinct from military engineering, and from architecture. From this period, therefore, we may regard the separation of the three professions as having become effective." The School had many students who distinguished themselves, and one of these was Jacques-Élie Lamblardie (1747–97), who succeeded Perronet as director and held that position at the time of the Revolution, when for a time the School was merged in the École Centrale des Travaux Publics. He had previously done good work on the rivers and harbours of Normandy, erected a bascule bridge at Le Havre, and commenced a series of large-scale tests on timber, which were after his death continued by his colleagues.

Of never-ending interest is the period which saw the work of Huygens, Newton, Boyle, Leibniz and Hooke, and the founding of the Royal Society and the Academies of Sciences in Paris, Berlin and elsewhere. All these men and institutions are recalled by the lives of Denis Papin and Mårten Triewald. Papin was born three hundred years ago, and Triewald died two hundred years ago. At various times the assistant of Boyle, Huygens and Hooke, correspondent of Leibniz, curator of the Royal Society and the first to show how to construct an atmospheric machine having cylinder and piston, Papin once wrote to Leibniz in 1696: "The number of machines and new inventions which I have in my head becomes ever greater, and I have no stronger desire than to live to see their effect, which they will produce as soon as they can be properly constructed". One of the things Papin sought to do, Thomas Newcomen achieved, and part of Triewald's fame is due to the construction by him of the first Newcomen atmospheric pumping engine seen in the Swedish mines. His stay of ten years in England had made him known to Newton and Desaguliers, and back in his own country he lectured here and there on experimental science. He also made a collection of instruments still preserved in the University of Lund. An active, energetic and versatile man, he was one of the six founders of the Royal Swedish Academy of Science. A translation of his "Short Description of the Atmospheric Engine" (1734) was published by the Newcomen Society in 1928. Papin was born at Blois, France, on August 22, 1647, and died some time after 1712. Triewald was born in Stockholm, being baptized on November 21, 1691; he died on August 8, 1747. Papin is also remembered for his invention of the digester known by his name. It is recorded by Evelyn that Papin cooked a meal for some fellows of the Royal Society in his digester: "This philosophical supper caused much mirth amongst us and exceedingly pleased all the company".

In 1908 the tercentenary of the birth of Evangelista Torricelli was celebrated at Faenza. Later on, under the auspices of the municipality of that town, his collected works were published in three volumes; a review of them appeared in *Nature* of January 29, 1920. This year marks the tercentenary of his death, and also of that of his countryman, Bonaventura Cavalieri, who was born ten years before Torricelli. One has an assured place in the history of science for his discovery of the pressure of the atmosphere and his invention of the barometer; while the other is remembered among mathematicians for his method of indivisibles. The two men were friends of Galileo, through whom Cavalieri was appointed to the chair of mathematics in the University of Bologna. In France, the year 1647 saw the death of Claude Mydorge, an associate of Descartes and Fermat, and a member of the small society from which sprang the French Academy; while in Copenhagen on October 8, 1647, the death occurred of Christian Longomontanus, who worked during 1589–98 with Tycho Brahe at Uraniborg, and from 1605 until his death held the chair of mathematics at Copenhagen.

Finally, looking back yet another century, in 1547 Johann Schoner, the contemporary of Copernicus, died at the age of seventy. For many years he was a professor of mathematics in Nuremberg, and wrote on the globes, geography, dialling and astronomy. It was to him that the enthusiastic Rheticus wrote after visiting Copernicus: "Believe me, most learned Schonerus, that this man, my instructor, in all kinds of learning, and in the science of astronomy, is not inferior to Regiomontanus. I freely compare him to Ptolemy; not that I think Regiomontanus less than Ptolemy, but because my preceptor has a felicity in common with Ptolemy, that, by the Divine Assistance, he would finish the Reformation of Astronomy; whereas Regiomontanus, O cruel fate! died before he had erected his pillars".

OBITUARIES

Dr. Hugo Obermaier

With the death of Hugo Obermaier, which has recently taken place at Fribourg in Switzerland, prehistorians have lost a pioneer colleague of international reputation, the author of at least two widely known books and numerous important articles which have appeared in learned journals; his friends a figure beloved for the unselfish dignity and fidelity of his nature; and the Continent of Europe one of those, alas, now all too rare learned men to whom frontiers are unimportant. He was a good European—if a saddened one.

Born in 1877, the son of the civic librarian of Ratisbon in Bavaria, he studied in Vienna under Hoernes and others, and early developed a flair for prehistory, working at pleistocene geology with the famous Albrecht Penck. In 1904 he went to Paris, and there first met his life-long friend, the Abbé Breuil. The latter has told me the following anecdote of Obermaier at this time which is characteristic of his fine personality. It appears that he was hoping

to be elected to a chair at Fribourg, not knowing that his new friend, too, had similar ambitions. When he learnt the position, he told Breuil at once that he was no longer a candidate, adding: "I indeed prefer your friendship to this chair".

In 1909 Obermaier was associated with Breuil and the late Prince of Monaco in excavating the great prehistoric home-site at Castillo in North Spain, and a few years later, when the Prince founded the Institut de Paléontologie humaine at Paris, he was named as one of the professors. He travelled much with Breuil at this time both in France and Spain, studying sections, home-sites and cave art. The fateful year 1914 found him concluding the excavations at Castillo, and he remained in Spain throughout the First World War, being granted a small post at Madrid. Later he accepted Spanish nationality. Between the wars he worked in Spain, until the Spanish civil war drove him to Switzerland, with the loss in Madrid of many valuable papers. When the Second World War broke over Europe, he was occupying a post in Fribourg, where he was laid low by a stroke some months ago, and has recently died. Like Breuil, he was a Roman Catholic priest, but, again like his colleague, he never held a cure of souls.

Prof. Obermaier's quaternary geological work, both in the Pyrenees and the Cordillera Cantabrica, was a real contribution to knowledge, as, too, were his numerous excavations and his work at the painted cave of Pileta in the extreme south of Spain. The personal impact of the tragedy of three wars in his learned life may perhaps have prevented the full stature of his mind from making itself felt as widely as it might otherwise have done; but those who knew him always felt and deeply respected the relentless integrity of his mental powers as much as they loved his personal qualities. They can only regret his passing—knowing that science has lost in him an honest and tireless investigator.

M. C. Burkitt

Prof. J. Bečka

The November issue of *Chemické Listy* records the death at Mauthausen camp on February 25, 1942, of the biochemist, Dr. Jan Bečka, three days after his fifty-third birthday. Prof. Bečka graduated at Prague in both medicine and the natural sciences, and his first researches established the chemical and physical identity of certain types of keratin from various sources. In 1919 he became lecturer in chemistry at the Brno Veterinary College and was appointed professor in 1926, which post he held until the College was closed in 1939.

Bečka's later researches related to problems of ion exchange in pathological conditions, and he studied the effects of calcium and phosphorus in cases of narcosis. He was especially interested in mineral metabolism, and made elaborate studies of the effects of magnesium in animal metabolism. Most of his publications (eighty-six in all, or more than a hundred if those with students are included) appeared in Continental journals, and though some of his earlier researches were known to British colleagues, his last two books on the biochemistry of healing (1940) and the biochemistry of cancer (1941) probably remain unknown outside Czechoslovakia.

Bečka frequently visited Britain, Canada and the United States; he was responsible for introducing the use of insulin into Czechoslovakia.

J. K. Lubanski

Jozef Kazimierz Lubanski, a Polish physicist who was working at the Laboratory for Aero- and Hydrodynamics of the Technical University at Delft, died on December 8, at the age of thirty-two. After having obtained the degree of *magister philosophiæ* at Wilna in 1937, and worked for two years as an assistant in theoretical physics at Polish universities, Lubanski obtained a grant in order to travel to Holland and to work under Prof. H. A. Kramers at Leyden. His original intention was to go to Copenhagen in the following year; the War prevented this, and for some time he worked with Prof. L. Rosenfeld at Utrecht. A number of papers dating from this period, mostly in *Physica*, one in the *Arkiv för Matematik, Astronomi och Fysik*, deal with the properties of mesons and similar particles considered in relation to quantum mechanics.

Since the autumn of 1945, Lubanski had been assistant at the Laboratory for Aero- and Hydrodynamics of the Technical University at Delft. He studied with considerable success the theoretical aspects of this subject, but he had not yet published any of his work.

Lubanski's death is felt as a great loss by his many friends; he was much liked both for his personal character and for his scientific knowledge, as well as for that of philosophy and general literature.

J. M. Burgers

Prof. J. G. Koenigsberger

News has been received of the death of Prof. Johann Georg Koenigsberger, 33 Wildtalstrasse, Freiburg i. Breisgau (17B), French Zone, Germany, in his seventy-first year. Prof. Koenigsberger was well known for his work on the magnetic properties of minerals, and at the time of his death he was in communication with physicists in England with regard to the publication of a paper which he submitted in 1939 and which was held up during the War; the paper was concerned with changes of coercivity with grain size.

Prof. Koenigsberger was suspended from his chair in 1933 and dismissed from the University of Freiburg i. Breisgau in 1934 for having been republican deputy in the Diet of Baden and because of his partly Jewish ancestry. His daughter came to Britain in 1935 and served in the A.T.S. during the Second World War. Koenigsberger was reinstated as professor at the close of hostilities, and carried on theoretical research work under difficulties until the time of his death.

L. F. B.

We regret to announce the following deaths:

Mr. William Barnicot, M.B.E., secretary of Rothamsted Experimental Station since 1920, on December 30, aged seventy-four.

Prof. Paul Langevin, For.Mem.R.S., director of the École de Physique et Chimie Industrielle, Paris, on December 19, aged seventy-four.

Prof. Edward L. Mark, emeritus professor of zoology in Harvard University, aged ninety-nine.

Mr. C. C. Robertson, formerly chief research officer and professional assistant to the chief conservator of forests, Department of Forestry, South Africa, on December 3, aged sixty-two.

Mr. R. N. Vyvyan, formerly engineer-in-chief of the Marconi Co., and one of the pioneers of radio-communication, on December 14, aged seventy.

NEWS and VIEWS

New Year Honours List

THE names of the following men of science and others associated with scientific work appear in the New Year Honours List:

O.M.: Field Marshal J. C. Smuts.

Hon. O.M.: Mr. John Winant.

Viscount: The Right Hon. S. M. Bruce, chairman of the International Emergency Food Council.

Baron: Sir Ernest Simon, for public services.

G.C.B.: Sir Alan Barlow, second secretary, H.M. Treasury.

K.C.V.O.: Evelyn C. Shaw, secretary to the Commissioners of the Exhibition of 1851.

Knights: Major G. St. J. Orde Browne, labour adviser, Colonial Office; Major-General H. C. Buckley, formerly principal of the Medical College, Agra; Dr. W. H. Coates, a deputy-chairman of I.C.I., Ltd., for services to Government departments; Prof. Kerr Grant, professor of physics in the University of Adelaide, for public services; Prof. W. N. Haworth, Mason professor of chemistry and director of the Chemistry Department, University of Birmingham; Prof. C. E. Hercus, professor of bacteriology and preventive medicine and dean of the Medical School, University of Otago; Dr. E. W. Smith, lately president of the Institute of Fuel; R. Thomas, agricultural adviser to the Government of Sind, and managing director of Sind Land Development.

C.B.: Air Commodore F. Whittle.

C.M.G.: Prof. P. A. Buxton, professor of entomology in the University of London and director of the Department of Entomology, London School of Hygiene and Tropical Medicine; A. D. Storke, for services in connexion with mineral resources in the Colonial Empire.

C.I.E.: A. P. F. Hamilton, inspector-general of forests, India; Colonel O. Slater, director of the Survey of India; Lieut.-Colonel W. J. Webster, senior assistant director, Central Research Institute, Kasauli.

C.B.E.: Prof. F. T. Brooks, professor of botany in the University of Cambridge; O. V. Guy, secretary of the Cambridge University Appointments Board; Prof. T. D. Jones, professor of mining in the University of Wales, and director of the Mining Research Laboratory, University College, Cardiff; Dr. F. C. Toy, director of the British Cotton Industry Research Association; Prof. T. Wallace, director of the Bristol University Agricultural and Horticultural Research Station, Long Ashton.

Indian Science Congress Association

THE Indian Science Congress Association is meeting in Delhi during January 2–8 under the presidency of Pandit Jawaharlal Nehru. The general theme of the meeting is research and national planning. The executive committee of the Association has taken an initiative among Associations for the Advancement of Science in planning to make its annual meetings international occasions; strong delegations of men of science from a number of countries will attend the meeting at Delhi, and some will remain in India for a number of weeks visiting centres of individual interest, lecturing and advising. The British delegation, appointed by the Royal Society and the British Association, includes Prof. P. M. S. Blackett, Prof. W. Brown, Sir Charles Darwin, Sir Arthur Fleming, Prof. H. Munro Fox, Sir Harold Spencer Jones, Prof. L. J. Mordell, Prof. L. Dudley Stamp and Sir D'Arcy Thompson. The British party travelled from London Airport in company with the delegations from Canada, the United States and France.

Charles L. Mayer Award: Dr. C. Jayaratnam Eliezer

A CHARLES L. MAYER AWARD of 2,000 dollars, offered by the National Science Fund of the U.S. National Academy of Sciences for an essay on the nature of light, has been allocated to Dr. C. Jayaratnam Eliezer, for a paper on "The Interaction of Particles and an Electromagnetic Field". Dr. Eliezer, who is twenty-eight years old, is a native of Ceylon. After a distinguished career at the Ceylon University College, he entered Christ's College, Cambridge, and read for the Mathematical Tripos. He began research studies in quantum mechanics under the supervision of Prof. P. A. M. Dirac, and won an Isaac Newton Studentship and a Smith's Prize. During 1943–46 he was lecturing at the University of Ceylon, returning to Cambridge in 1946 as a research fellow of Christ's College. A second Charles L. Mayer Award was offered but was not awarded, no other essay received being considered suitable.

Sir Ben Lockspeiser

As announced in *Nature* of December 14, p. 867, Sir Ben Lockspeiser has been appointed chief scientist to the Ministry of Supply. Sir Ben, who is fifty-five, was at Sidney Sussex College, Cambridge. During the First World War he served in Gallipoli and Egypt. He afterwards worked at the Admiralty's Laboratory at Sheffield, and was for a time in the Inventions Department of the Ministry of Munitions. He joined the Royal Aircraft Establishment in 1921. His first work was to assist Dr. A. A. Griffith in investigations on phase complexity and on stress concentration in plastic crystals. He turned his attention, at the R.A.E., to a variety of aeronautical problems, such as wing flutter, instrument design, the design of windscreens and the prevention of ice accretion. Sir Ben was responsible, with Dr. Ramsbottom, for the development of the early form of chemical anti-icing device consisting of a porous wing nose-piece kept saturated with ethylene glycol, afterwards manufactured by the Dunlop Rubber Co. In 1936 he transferred to the Air Defence Department of the Royal Aircraft Establishment, where he was closely concerned with the development of the balloon barrage in the form in which it played an important part in defence during the Second World War, his work including theoretical aspects of the interception problem, practical trials and the effect of the employment of the barrage on aircraft design.

In 1939, Sir Ben moved to Air Ministry headquarters as assistant director of scientific research. In the Ministry of Aircraft Production he became in 1941 deputy director with responsibility for research on armaments, including fuses and aerial mine barrage schemes. He succeeded Dr. D. R. Pye as director of scientific research in 1943, and was made a director-general in 1945. He was knighted in January 1946.

Physical Society Awards :

Duddell Medal

THE twenty-third Duddell Medal of the Physical Society has been awarded to Dr. Karl Weissenberg of the Shirley Institute, Didsbury, Manchester, in recognition of his invention and development of X-ray goniometers, the first of which was described in 1924, when he was engaged in the Institute for Fibre Chemistry of the Kaiser Wilhelm Institut. In this instrument the rotation of the crystal is linked to the to-and-fro movement of a cylindrical photographic film parallel to its axis during the exposure. The diffracted spots are thus connected with the orientation of the crystal, are recorded without overlapping, and are readily indexed. The instrument was almost before its time, for the full value of photographic methods, and especially of the rotation method, was not then realized, except perhaps by Weissenberg himself. With the development of the method of the reciprocal lattice and of Fourier synthesis of complex structures, however, the Weissenberg goniometer has become almost indispensable. It is now widely used, and has been responsible for a great advance in our knowledge of crystal structure.

Dr. Weissenberg pointed out at the time that his design embodied only one possible combination of crystal and film movements ; and that others, which he described, were likely to be useful. These have since been embodied in other designs ; in the double Weissenberg goniometer comparison is made with a standard crystal, so that intensity measurements shall be on an absolute scale. But the original Weissenberg goniometer is still that most generally used. The presentation of the Duddell Medal will take place at a scienc meeting of the Physical Society at the Scienc Museum, South Kensington, on January 10.

Charles Vernon Boys Prize

THE Council of the Physical Society has made the second (1946) award of the Charles Vernon Boys Prize to Robert William Sutton, superintendent scientist at the Admiralty Services Electronics Research Laboratory, Baldock, Herts, for his work in the development of receiving valves and cathode-ray tubes for radio and radar, notably the velocity-modulated local oscillators (the Sutton valve) for use on centimetric waves, and the Skiatron tube by means of which a picture can be produced from a radar beam. Sutton's research career began in 1929 at the Imperial College of Science and Technology, where he collaborated with Prof. G. I. Finch in a successful study of the induction coil. He afterwards went to Ferranti, Ltd., where he brought the valve factory into efficient operation, to E. K. Cole, Ltd., and to Scophony, Ltd., where he was primarily interested in television research. Early in 1939 Sutton was appointed a senior scientific officer at the Admiralty Signal Establishment (School at that time) and given charge of the research section of the valve division ; he became principal scientific officer in 1944 and superintendent scientist in 1945. The award will be presented to Mr. Sutton at the meeting of the Physical Society on January 10.

British Council Science Office in China : Dr. R. A. Silow

DR. R. A. SILOW, until recently scientific officer of the Agricultural Research Council at the Plant Breeding Institute, Cambridge, has been appointed director of the British Council's Science Office in China, in succession to Dr. Joseph Needham, who is now with the United Nations Educational, Scientific and Cultural Organisation. Dr. Silow is a graduate of the University of Reading in agricultural botany. He did research in genetics at the Welsh Plant Breeding Station, Aberystwyth, during 1929–33. He then went to the Empire Cotton Growing Corporation's Cotton Research Station, Trinidad, B.W.I., remaining there until 1944. He was visiting professor of plant genetics at the Blandy Experimental Farm of the University of Virginia during 1944–45 ; after which he became scientific officer of the Agricultural Research Council, attached to the Plant Breeding Institute, School of Agriculture, University of Cambridge. His work has included investigations on Asiatic cottons in collaboration with the Chinese Agricultural Research Bureau at Nanking.

Trans-uranium Elements in Chemistry

DELIVERING this year's Harrison Howe Lecture on November 18 to the Rochester Section of the American Chemical Society, Prof. G. T. Seaborg referred to the importance which the newly discovered trans-uranium elements may achieve for general chemistry. Those of comparatively short life-time, and therefore high radioactivity, will always require special training for their safe handling ; consequently, neither plutonium (element 94), nor americium (element 95), which only recently has been prepared in pure form, can be handled without certain precautions ; neptunium (element 93), however, with a life-time of more than two million years, may eventually find its way into the ordinary chemical laboratory as one of the rarer elements. Curium (element 96), which so far occupies the last place in the Periodic System, is remarkable in being the element with the highest atomic weight ; Prof. Seaborg expects that, in addition to the isotope 242, which is produced by the neutron bombardment of americium, still heavier ones with atomic masses up to 246 may be obtained.

British Association of Chemists : Annual General Meeting

THE twenty-ninth annual general meeting of the British Association of Chemists was held on December 7. Prof. R. G. W. Norrish, retiring president, presented the Hinchley Medal to Mr. C. S. Garland, and in doing so he paid tribute to the work which Mr. Garland had done for the Association over a long period of years and for the profession of chemistry. The following officers for the ensuing year were elected : *President*, Norman Sheldon ; *Vice-Presidents*, Prof. R. G. W. Norrish, Dr. J. B. Matthews, J. Wilson and C. A. Wylie ; *Hon. Secretary*, J. Stewart Cook ; *Hon. Treasurer*, W. C. Peck ; *Hon. Registrar*, H. L. Howard ; *Hon. Editor*, T. Crosbie Walsh. Two proposed alterations to the rules of the Association were adopted. One gave authority to increase benefits under the Unemployment Benefit Fund, and the other established the office of honorary life vice-president, to which Prof. E. C. C. Baly was elected, in recognition of the valuable work he had done for the Association during the past years. A resolution, from the Manchester Section, was adopted to put the Association's political fund into active operation. There would be no suggestion of assisting any particular political party ; the object was to assist chemists to play their part in public affairs, and to let them feel that they had the goodwill of their fellows.

In assuming the office of president, Mr. Sheldon made a statement of policy. The British Association of Chemists is not, nor does it pretend to be, a qualifying body; but it is the only organisation which exists for the sole purpose of looking after the economic interests of the chemical profession. It gives members financial support from its Unemployment Benefit Fund, which has a reserve of more than £42,000; and it is exploring the possibility of setting up a superannuation scheme which will be transferable when a member moves from one firm to another. It is also hoped to extend the unemployment benefit scheme to cover loss of income through sickness or accident. A comprehensive appointments service is provided. The Association aims at recognition by industrial firms, Government departments and public authorities as the appropriate body with which all matters relating to the economic interests and the status of chemists should be discussed. To this end it is registered as a trade union; but it is not in any way associated with any particular political party. An important activity of the Association is the formation of student groups through which students of chemistry can take an interest in matters concerning their present and future economic welfare, and secure the co-operation and advice of the senior members.

New Culture Medium for *Penicillium notatum*

In the absence of supplies of penicillin in Hungary during the War, Dr. E. Rosenthal, of St. Roch's Hospital, Budapest, isolated two strains of what appeared to be *Penicillium notatum* Westling from which were prepared filtrates exhibiting antibiotic activity against isolated strains of *Staphylococcus albus*. Since glucose or other forms of sugar required for the usual culture media were extremely difficult to obtain, substitutes were sought. The urine of diabetic patients was ultimately found to provide a good culture medium for the mould, and, for the routine production of penicillin-active filtrates, was adjusted to contain 4 per cent of sugar. The acidity was adjusted to the usual *p*H of the Czapek-Dox medium and, after filtration and sterilization, the urine was inoculated with the spores of the mould. In comparison with the Czapek-Dox medium, diabetic urine produced in most instances accelerated development of the mould with the appearance of as much as three times the amount of antibiotic activity. Similar results were usually obtained with a medium prepared by the addition of 4 per cent of glucose to normal human urine. The addition to a culture medium of substances such as indol-acetic acid is known to stimulate penicillin production, and the results obtained with diabetic urine are probably to be ascribed to the presence therein of stimulating substances of this and other types.

Disappearance of a Mendel Manuscript

Dr. Jaroslav Kříženecký, of the Zootechnical Research Institute and College of Agriculture in Brno, Czechoslovakia, has informed Dr. Herbert C. Hanson, chief of the Agricultural Division, United Nations Relief and Rehabilitation Administration Mission to Czechoslovakia, that Mendel's manuscript "Versuche über Pflanzen Hybriden" has disappeared. This manuscript had been in the custody of the Natural History Society in Brno since 1910, when it was found by Prof. Hugo Iltis in a waste-paper basket in the Society's library. In 1939, when the Germans occupied Brno, Dr. Otto Richter, professor of botany in the German Technical College in Brno, took over the chair of plant physiology in the Faculty of Science in the Masaryk University. All the buildings and facilities of this University were turned over to the German College. Some of the Czech assistants were persuaded to remain under Richter. They have informed Dr. Kříženecký that Prof. Richter, after he had taken over the apartments of the Natural History Society, carried Mendel's manuscript about with him in his brief-case. Richter was also a student of Mendel's history and wrote several publications about Mendel during the War. When the Germans were evacuating Brno upon the approach of the Russians, Richter disappeared. It is thought that he may have taken Mendel's manuscript with him either to Germany or Vienna. So far, the whereabouts of Prof. Richter and of the manuscript are unknown. It is to be hoped that further official aid will be given in searching for this interesting document, which should be returned to Brno.

Tibetan Culture

Tibet has always been a mystery land, and even now little is accurately known of its story. Cheng Te-k'un and D. Michael Sullivan, in No. 6 of the Guidebook Series issued by the West China Union University Museum, Chengtu, Hwasipa, have produced a pamphlet of forty pages intended to supply this need. Much information is given, even if in a rather dull manner and without any illustrations. Anyone wanting to know something of the dry bones of Tibetan history will find much that he is seeking here.

Polar Exploration Exhibition

An exhibition illustrating the story of polar exploration to the present day is open to the public at the Royal Geographical Society's House (Exhibition Road entrance) during January 4–18 inclusive, 11 a.m. to 4 p.m. daily, except Sundays. The history of polar exploration is shown by paintings, prints, maps and photographs as well as personal relics of famous polar explorers; and a selection of modern equipment, including that used by the Royal Navy, the Army and the Royal Air Force, demonstrates modern technical developments.

Conference on Pulverized Fuel

A conference on pulverized fuel is being organised under the auspices of the Institute of Fuel and will be held in Harrogate during June 3–6. Some fifty papers have been promised from authorities in Great Britain, and contributions are also expected from South Africa, Australia, the United States, France, Holland and Germany. The papers are to be published in a book which will be sent four weeks before the opening session to all who take up membership of the conference. This book will contain, as well as the papers, an index to authors, an index to subjects, and the programme for each session. Each programme will set out the points to be discussed at that session with a cross-index to the comments of the authors upon them. Each session will be devoted almost wholly to discussion, following a short survey outlining the topics for that session. Membership of the conference will be open to anyone interested in pulverized fuel. Particulars can be obtained in due course from the Pulverised Fuel Conference Committee, Institute of Fuel, 18 Devonshire Street, London, W.1.

University of London : Appointments

THE title of professor emeritus of physics in the University of London has been conferred on Dr. Sydney Russ on his retirement from the Joel chair of physics which he has held at the Middlesex Hospital Medical School since 1920. He has been succeeded by Dr. J. E. Roberts, formerly assistant physicist in the School.

The title of professor emeritus of Chinese art and archæology in the University has been conferred on Dr. W. P. Yetts on his retirement from the chair of Chinese art and archæology at the Courtauld Institute of Art which he has held since 1932.

Dr. Reinhold Fürth has been appointed to the University readership in theoretical physics tenable at Birkbeck College as from January 1. During 1931–39 he was professor of experimental physics and head of the Physics Department in the University of Prague, and since 1942 he has been on the staff of the University of Edinburgh as Dewar Research Fellow and part-time lecturer.

The title of reader in the University has been conferred on the following in respect of the posts they already hold: Dr. G. B. Brown (physics), University College; Dr. F. C. Champion (experimental physics), King's College; Dr. E. T. Davies (mathematics), King's College; Dr. Benjamin Dawes (zoology), King's College; Mr. M. B. Donald (chemical engineering), University College; Dr. M. S. Fisher (metallurgy), Imperial College of Science and Technology; Dr. G. W. Himus (fuel technology), Imperial College of Science and Technology; Dr. C. C. N. Vass (physiology), St. Thomas's Hospital Medical School; Dr. M. J. D. White (zoology), University College; Mr. E. W. Yeoman (metallurgy), Imperial College of Science and Technology.

The degree of D.Sc. has been conferred on Mr. E. E. Cheeseman, Imperial College of Science and Technology; Mr. C. W. Davies, recognized teacher at Wye College; Mr. R. L. Noble, Middlesex Hospital Medical School; Mr. J. M. Watson, recognized teacher at Northern Polytechnic.

Earth Tremor in Scotland

ON December 25, soon after 5 p.m., an earth tremor was felt in the Lochaber district of Inverness-shire. It is reported to have begun with a faint rumbling noise, which increased to a loud roar and continued for some seven seconds. The earth tremor rattled crockery on the shelves in houses at Spean Bridge, and the shock was faintly felt at Fort William. No damage has been reported. The tremor was no doubt caused by slipping along one of the faults associated with the Highland boundary.

The Night Sky in January

FULL moon occurs on Jan. 7d. 04h. 47m., U.T., and new moon on Jan. 22d. 08h. 34m. The following conjunctions with the moon take place: Jan. 8d. 12h., Saturn 4° S.; Jan. 16d. 13h., Jupiter 0·6° S.; Jan. 18d. 03h., Venus 4° N. Mercury is a morning star, rising at 7h. 23m. on Jan. 1, and is in superior conjunction on Jan. 23. At the end of the month the planet rises about quarter of an hour after the sun and is not then well placed for observation. Venus is a morning star, rising at 4h. 23m., 4h. 27m., and 4h. 42m. at the beginning, middle and end of the month respectively. The planet attains its greatest westerly elongation on Jan. 28. Mars, in conjunction on Jan. 6, is too close to the sun for favourable observation. Jupiter is visible in the early morning hours, rising at 4h. on Jan. 1 and 2h. 30m. on Jan. 31. Saturn is visible through the greater portion of the night, rising at 18h. 17m., 17h. 17m., and 16h. 03m. at the beginning, middle and end of the month respectively, and is in opposition on Jan. 26. The following occultations of stars brighter than magnitude 6 take place: Jan. 5d. 21h. 58m., 132 Taur. (*D*); Jan. 31d. 20h. 57·2m., ω Taur. (*D*); *D* refers to disappearance, and the latitude of Greenwich is assumed. The earth is at perihelion on Jan. 4, its distance from the sun then being 91,449,000 miles.

Announcements

MR. KENNETH B. DISHER has been appointed director of the Cleveland Museum of Natural History, Cleveland, Ohio. He was formerly executive secretary of the Allegany State Park Commission, New York, and prior to that associated with the National Park Service, U.S. Department of the Interior. Mr. Disher is a graduate of Pomona College and has also worked at Harvard University.

DR. E. A. STEWARDSON has been appointed to the newly established chair of physics at University College, Leicester.

DR. R. J. SARJANT, head of the Research Department of Messrs. Hadfield's, Ltd., known for his work on a wide range of fuel problems, especially those relating to the steel industry, has been appointed to the chair of fuel technology in the University of Sheffield; this chair has been vacant for several years.

ANTICIPATING a further increase in advisory work in 1947, the Board of Greenkeeping Research has appointed Mr. J. H. Arthur as an additional advisory officer at the St. Ives Research Station, Bingley, Yorkshire. Mr. Arthur graduated at the University of Reading in 1946 after serving five years in the Army.

MR. F. A. FOX, chief metallurgist of Magnesium Elektron, Ltd., is joining the British Welding Research Association as assistant director of research. Mr. Fox has been engaged in metallurgical research, particularly in the light alloys, since 1934, in both the ferrous and non-ferrous fields, and has had considerable experience in the organisation of this kind of work.

A COURSE of twelve lectures on television practice will be given on Friday evenings at 7 p.m. commencing on January 17 in the Electrical Engineering Department, Northampton Polytechnic, St. John Street, London, E.C.1. The fee for the course is 15*s*.

A CONFERENCE on "The Family at Work and Play", to be held at the Institution of Civil Engineers on January 16–17, is being organised jointly by the British Social Hygiene Council and the Town and Country Planning Association. The conference will be opened by a paper by Mr. Gilbert McAllister on "The Family and the Nation". Other papers will be given during the following sessions: "The Family at Home"; "The Family at School"; "The Family Growing Up"; "The Family at Work"; and "The Family at Play". Further information can be obtained from either the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1, or the Town and Country Planning Association, The Planning Centre, 29 King Street, Covent Garden, London, W.C.2.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Technetium: the Element of Atomic Number 43

In 1937, Perrier and Segrè showed that radioactive isotopes of element 43 could be formed by neutron or deuteron bombardment of molybdenum[1]. Several chemical properties of element 43 were established at that time, and some nuclear properties of the spectral isotopes. These isotopes were found after nuclear bombardments by the 37-in. cyclotron of the Radiation Laboratory of the University of California.

Later on, Wu and Segrè found also element 43 among the fission products of uranium, a source from which relatively large amounts of 43 can be isolated[2].

It seems appropriate now to give a name to this element, as suggested by Paneth[3]; and we would like to propose the name of 'technetium', from the Greek τεχνητός, artificial, in recognition of the fact that technetium is the first artificially made element. The corresponding chemical symbol should be 'Tc'.

C. Perrier

University of Genoa,
Italy.

E. Segrè

University of California,
Berkeley, California.
Nov. 29.

[1] Perrier, C., and Segrè, E., *J. Chem. Phys.*, **5**, 712 (1937); **6** (1938).
[2] Segrè, E., and Wu, C. S., *Phys. Rev.*, **57**, 552 (1940).
[3] Paneth, F. A., p. 8 of this issue of *Nature*.

Astatine: the Element of Atomic Number 85

In 1940, we prepared the isotope of mass 211 of element 85 by bombarding bismuth with alpha particles accelerated in the 60-in. cyclotron of the Radiation Laboratory of the University of California[1].

At that time we established several chemical properties of element 85 and we made a fairly complete nuclear study of the isotope formed.

It has been pointed out to us[2] that a name should now be given to this new element, and following the system by which the lighter halogens, chlorine, bromine and iodine, have been named, namely, by modifying a Greek adjective denoting some property of the substance in question, we propose to call element 85 'astatine', from the Greek ἄστατος, unstable. Astatine is, in fact, the only halogen without stable isotopes. The corresponding chemical symbol proposed is 'At'.

D. R. Corson

Cornell University,
Ithaca, N.Y.

K. R. Mackenzie

University of British Columbia,
Vancouver, B.C.

E. Segrè

University of California,
Berkeley, California.
Nov. 29.

[1] Corson, D. R., Mackenzie, K., and Segrè, E., *Phys. Rev.*, **57**, 1087 (1940).
[2] Paneth, F. A., p. 8 of this issue of *Nature*.

British Universities and 'Secret' Theses for Degrees

In his presidential address to the Royal Society, Sir Robert Robinson is reported in *Nature* of December 7 (p. 825) as having said, "Nevertheless, the universities have preserved intact their precious liberty of action, and I see no signs of any attempt to curtail it. Surely this suggests a feasible line of demarcation in that extra-mural contracts, placed by Service departments with the universities, need not, and should not, contain any clauses restricting free publication of the results. Although it has sometimes been irksome, the refusal of many universities to accept theses that cannot be published is a step in the right direction."

Whatever the views and practices of the Defence Departments may have been in the pre-war and war-time years, it is certain that those now responsible for the organisation and direction of defence research in Great Britain are as genuinely interested as academic scientists themselves in the maintenance of complete independence and liberty of action for British universities in the field of scientific research. Within the last year, defence science representatives have met to pool their views on policy in the placing of extra-mural contracts, and were unanimous in deprecating any form of pressure on the universities to accept research contracts of the kind which seem likely to lead to unpublishable results.

But Sir Robert Robinson's commendation of the refusal of many British universities to accept unpublishable theses must not pass unchallenged. Since no scientific worker doing research in a university laboratory should be producing unpublishable results, there should arise no demand on universities to grant 'internal' degrees based on secret theses. The undertaking of research in a university laboratory is, however, not an invariable requirement for the award of higher degrees such as M.Sc., Ph.D., and D.Sc., and the refusal to award such degrees to 'external' scientific workers on unpublishable results deprives the young research worker entering a Government defence laboratory of any *assured* opportunity to submit the results of his research for a higher degree.

Non-acceptance of unpublishable theses by universities thus becomes a serious handicap to recruitment of scientific men for defence research. In addition, it is a potential handicap to the defence research worker whenever he may seek return to a university or industrial scientific career, for there is no denying that the possession of a research degree is an asset when seeking a scientific appointment, and it is likely to be the more needed if, for security reasons, one is prevented from describing one's research achievements in detail.

Bearing in mind how seldom it proves impossible to distil the scientific essence of a defence investigation from those operational aspects and implications which must remain secret, I would estimate that not more than four or five scientific men in defence establishments would wish to submit unpublishable theses each year to universities in Great Britain, and most, if not all, of these theses would become publishable within the space of a few years. The injury to national defence by refusal to accommodate these few scientific workers on an equal footing with colleagues in the academic and industrial world is surely disproportionate to any slightly harmful reaction upon the universities which the idealist may discern.

Sir Robert Robinson rightly points out that "it is inconsistent to praise our scientists for their outstanding contributions to the war effort and at the same time to suggest that they offend against our ethical code if they serve the country in a similar fashion during an uneasy peace". What ethical code would countenance freedom for all scientific workers but those in defence establishments to acquire professional qualifications? To justify the universities' attitude, it must be shown that something in the process of examining the research work and secret thesis of a defence scientific worker must inevitably so react on the university as to be an infringement upon its scientific liberty and independence. What indeed are the reactions the universities fear, and, with goodwill, can no safeguards be evolved to allay such fears?

If the realistic approach to this problem now unfortunately being followed by only one or two universities is condemned by scientific leaders, or indeed if it fails to be adopted by a wider circle of universities, it is certain to lead to an accelerated decline in the research talent of our defence laboratories and a degree of unpreparedness in defence that can only make an uneasy peace the more uneasy for us all. Before taking this responsibility on their consciences, universities should satisfy themselves that no compromise can be offered, and I would venture to suggest that the Royal Society might offer to mediate between the universities and the defence science departments in trying to work out some acceptable scheme. Any scientific worker in Great Britain should feel that he can count upon the active support of British science and British universities in alleviating so far as possible conditions which restrict his scientific freedom.

J. E. Keyston

Department of Research Programmes and Planning, Admiralty.

Dec. 12.

The assurance contained in the second paragraph of Dr. Keyston's letter is very welcome, and it will now be the fault of academic men of science and the universities themselves if the high ideal of unfettered research is not realized in practice.

The citation in the first paragraph shows that my remark about unpublishable theses was intended to apply to 'internal' students. It is clearly bound by juxtaposition and reference to the previous sentence. Thus in my opinion the refusal to accept secret theses from internal students is "a step in the right direction", because it underlines the desirability of freedom of scientific effort in the universities. Admittedly, however, the sentence, taken out of the context, would appear to cover the cases of scientific workers in defence establishments who wish to submit secret theses for higher degrees. A little earlier in the address quoted, it was recognized that such workers would not always be able to publish their results; an unfortunate consequence of the present state of world affairs. I agree that, with proper safeguards, it might be possible to devise ways and means whereby such results could be examined for a degree.

The matter is nevertheless very complex, and it is certain that a single system has little chance of general adoption. The University of London insists that all theses must be deposited in the University Library, but will examine work by suitably qualified external students. The University of Oxford, on the other hand, has accepted a certain number of secret theses during the War as an emergency measure, but requires residence of three or six terms duration before leave is given to supplicate for the degree of B.Sc. or D.Phil. respectively. The D.Phil., for example, is not regarded merely as a certificate of technical proficiency; it normally implies that its possessor has spent two years, under approved conditions, in an Oxford school of research. Provision is made for certain equivalents (see Examination Statutes, Statt. Tit. VI, Sect. vi, § 1, 2 and § 5, 2, 12).

These are but two examples of the different regulations in force, and in addition the variables on the side of the defence departments are numerous and include the questions of supervision and assessment of joint work.

I am in no position to estimate the probability of changes being made in the examination statutes, still less to forecast the direction of any such changes, but in view of the very varied circumstances, feel confident that, if the door is opened, each case will still have to be considered on its merits.

Furthermore, I think that there will be a general disinclination to award the higher doctorate on the results of unpublished work. Here again there may well be a few quite exceptional cases, and sufficient elasticity to deal with them is perhaps already provided. Thus at Oxford the Board of Faculties has power to vary the regulations subject to the approval of the General Board of the Faculties.

Where so many parties, interests and principles are involved, I doubt the feasibility of the mediation suggested by Dr. Keyston, and suggest that the problem must still be attacked in detail.

Finally, it should be added that the question affects categories other than scientific men in defence departments, and these include workers in Government laboratories generally, and in industrial research laboratories. These cases are especially important from the point of view of 'external', rather than from that of 'secret' work.

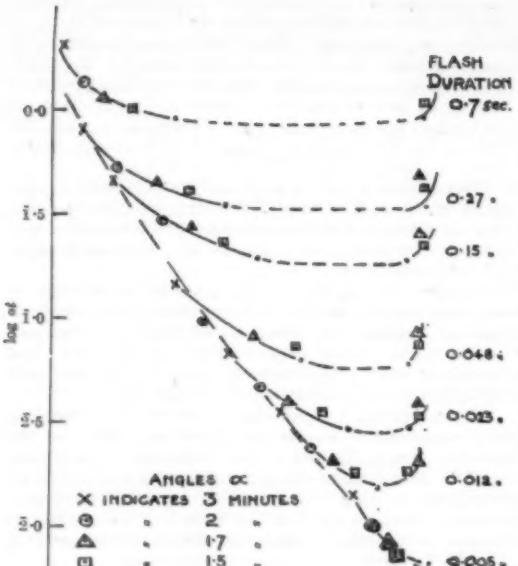
R. Robinson

Flash Visual Acuity

Most published researches on visual acuity have assumed an unrestricted time of observation, but recent studies of the relations between intensity discrimination and acuity, and photo-chemical theories thereof, have indicated that the wandering of fixation plays an important part in the performance of the visual system. It appears that a study of visual acuity in relation to exposure time may throw additional light on the subject.

During the past year, we have conducted some exploratory investigations which we hope will be extended by other workers in this laboratory and published in full; in the meantime, a note on the results so far obtained may be of interest.

The objects (shown in a dark field) were of the 'double star' type represented by two small equal and adjacent apertures which could be shown alternatively with a single aperture having double the area of a single one. Exposures ranged from 700 msec. to 2 msec., and intensities over a relative range of about 50 : 1. The observer used an artificial pupil, and had to report after a flash exposure whether the object was single or double. Fixation was assisted by the use of a faintly illuminated ring; some measurements were also attempted for extra-foveal vision. The limiting angles of perception were estimated from a statistical analysis of this one observer's answers. Though many thousands of observations



were made, the results naturally show various uncertainties due to complex psychological factors. We consider that the choice of this type of object has considerable advantages over gratings, etc., for this method of observation, and the results have, moreover, some technical interest in regard to navigation and other signals.

Some of the most significant results, for foveal observations, are shown in the accompanying graph, in which the log of 'visual limiting angle *times* duration of stimulus' is plotted against the log of 'brightness of source'. Looking at the points for 3′ and 2′ visual angles (represented by crosses × and circles ⊙ respectively) there is an approach to a definite relation suggested by the broken-line curve. Results for the given exposure times are connected by other lines, and it will be noticed that the points for 1·7′, 1·5′, and 1·3′ angles do not conform to the same relation. Hence while there is some reciprocity between visual angle and minimum exposure time for the larger angles (the product being roughly a single-valued function of the brightness of the object), this does not generally apply to the smaller angles. The amount of light needed for a given improvement of visual performance, between 1·7′ and 1·3′, at a given exposure time is much greater than would be calculated from the function just mentioned, and the discrepancy increases with the time of the exposure. A similar set of curves has been obtained for observations in which the object appeared at an angle of 0·5° with the (attempted) direction of fixation.

Niven and Brown[1], using a small 'single line' object (the direction of which had to be recognized) found no significant departure from a relation, giving the above product in terms of brightness, derived from Hecht's revised photo-chemical theory[2]; our results are inconsistent with their equation. On the other hand, in investigating the product of the brightness-discrimination fraction and time as a function of intensity, Graham and Kemp[3] found that reciprocity only applied for exposures shorter than a critical value.

If our results are used to plot curves of log 'brightness *times* time' against log 'time' for given visual angles, it appears that there is an approach to reciprocity between brightness and time for the larger angles up to a stimulus duration of about 0·4 sec.; but the critical period, if it exists at all, is apparently smaller for the smaller visual angles.

When studying the effect of increasing the brightness of the field on observing our object with fixed separation and with a constant duration of the flash, it is found that (if the separation is within certain limits) the 50 per cent threshold of correct observations will in general become possible at some level of the field brightness; on further increasing the brightness, the percentage of correct observations will reach a maximum and thereafter decrease. However, the curves flattened at the minima for the longer flashes (see the accompanying figure) are probably caused by the limitation of the retinal structure; the experiments included trials with 1·1′ separations which were not resolved (50 per cent threshold) in these experiments for any level of the brightness. The limiting values at the higher brightness level are much less certain than those at the lower.

The results appear to be consistent with the accepted view that acuity is associated with intensity discrimination, but also lead back to the idea that this discrimination is associated with the production of some minimum difference of concentration of photo-products in adjacent areas of the retina. This would be consistent, for very short exposures, with the reciprocity between visual angle and time for a given intensity, and between intensity and time for a given angular limit. Longer exposures involve increased wandering of the stimulus area over the retina, due to eye movements; this will diminish the chance of setting up the associated liminal concentration difference with weak stimuli, and will conversely tend to prevent an 'over-exposure' effect if the stimuli are too strong.

The application of the above criterion to the usual photo-chemical equation[2] can be made to yield sets of curves similar to those in the figure, but it seems advisable to await the results of fuller experiment (with light-adapted eyes, etc.) before searching for the values of the constants which will represent the results most nearly. It may be remarked, however, that if the short-exposure effects are adequately represented by this equation, the longer-term effects of adaptation may require a modification of its form.

L. C. Martin
W. Kaniowski

Technical Optics Section, Physics Dept.,
Imperial College, London, S.W.7.

[1] Niven and Brown, *J. Opt. Soc. Amer.*, **34**, 738 (1944).
[2] Hecht, *J. Gen. Physiol.*, **18**, 767 (1935).
[3] Graham and Kemp, *J. Gen. Physiol.*, **21**, 635 (1938).

Origin of Radio Emissions from the [illegible]urbed Sun

In a recent [illegible]ication[1] it was pointed out that thermal rad[illegible]n the solar corona should be detectable at [illegible]ths as long as one or two metres. This sou[illegible]ot account, however, for the much stronger e[illegible]s which are correlated with

sunspots[2,3,4]. It has been shown[5,6] that the latter emissions probably come from the immediate vicinity of active sunspots, and would require impossibly high source temperatures of about 10^9 degrees for explanation in terms of thermal radiation.

It is natural first to seek an explanation in terms of the kind of electrical discharge which causes the familiar terrestrial radio noise, namely, lightning flashes; but it is difficult, if not impossible, to see how such discharges could be produced in the always highly ionized solar envelope.

There is, however, a way in which coherent radio waves could be emitted by the ionized gases above the chromosphere. J. J. Thomson[7] showed that an electron gas possesses a natural period of oscillation given by $T = \sqrt{\frac{\pi m}{Ne^2}}$, where m and e are the electronic mass and charge (E.S.U.) and N is the number of electrons per c.c. I have found that in the presence of a magnetic field the medium possesses two such natural periods, both defined by the condition that the dielectric constant of the medium is zero. In the absence of collisional friction these oscillations could occur without radiation of energy, since the convection current is then exactly neutralized by the displacement current. The presence of even the small amount of such friction present in the solar atmosphere necessitates appreciable radiation. Calculation shows that in the 1–5-metre band radiation from one of the modes of oscillation (which by analogy with Appleton's magnetic-ionic theory of the ionosphere we shall call the 'ordinary' mode) is suppressed by absorption in the overlying layers. On the other hand, radiation from the 'extraordinary' mode will escape from the sun with appreciable intensity. This appears to provide a logical explanation of the observed polarization of this radiation, as previously reported[5].

Calculation shows that the observed radiation is likely to come from the borders of prominence material, which has a somewhat higher density and lower temperature than the surrounding coronal matter. This gives enhanced radiating power in these regions, while the sharp electron gradient reduces absorption of the escaping radiation.

In the regions above active sunspots there is no doubt more than one disturbing influence capable of setting the medium into oscillation. One type of disturbance, however, should be specially important on the borders of moving prominence material. In the presence of the magnetic field of the spots, the transverse motion of ionized matter is accompanied by the setting up of electric polarization on the side walls[8]. We know also that this flow is turbulent, so that eddies are constantly forming along these walls. The continual breakdown of polarization in these eddies can supply enough electrical energy to maintain the oscillation of the medium at the required amplitude.

An interesting but different theory of the above-mentioned radiations has been propounded recently by Kiepenheuer[9], who considers that the free spiralling of individual electrons in the magnetic field will produce the observed radiation. It is difficult to see how such motions, which are thermal in origin, could give rise to radiation more intense than that from a black body. Moreover, it is possible to show that the absorption of this radiation must be so great that no appreciable amount can leave the sun. Fuller details of all the relevant calculations will be published elsewhere.

This work is being carried out on behalf of the Council for Scientific and Industrial Research, Australia.

D. F. Martyn

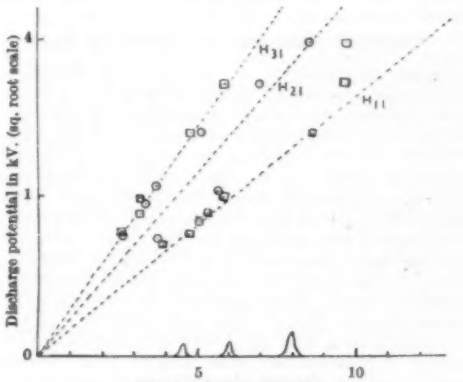
Commonwealth Observatory,
Canberra, Australia.

Nov. 4.

[1] Martyn, *Nature* [**158**, 632 (1946)].
[2] Appleton, *Nature*, **156**, 534 (1945).
[3] Hey, Phillips and Parsons, *Nature*, **157**, 297 (1946).
[4] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946).
[5] Martyn, *Nature*, **158**, 308 (1946).
[6] Ryle and Vonberg, *Nature*, **158**, 339 (1946).
[7] Thomson, J. J., *Phil. Mag.*, **11**, 697 (1931).
[8] Cowling, *Proc. Roy. Soc.*, A, **183**, 453 (1945).
[9] Kiepenheuer, *Nature*, **158**, 340 (1946).

Triatomic Hydrogen and Doppler Effect in Hydrogen Positive Rays

J. J. Thomson[1] discovered the triatomic molecule of hydrogen by the positive ray parabolic method. It was later confirmed by Dempster[2], Duane and Wendt[3], and several others. Its occurrence is very frequently noted in discharge tubes, but the optimum conditions are not well defined. While investigating the Doppler effect in hydrogen positive rays, using a Wien type of discharge tube, maximum Doppler displacements corresponding to H_3^+ molecules in the discharge space were observed. The accompanying graph gives the maximum Doppler displacements recorded in the $H\delta$ line of the Balmer series. A Steinheil three-prism glass spectrograph was used at two different dispersions, namely, 7·6 A. and 27·2 A. per mm. in the $H\delta$ region.



Maximum Doppler displacements in the $H\delta$ line
Dispersion: ○, 7·6 A. per mm.; ⊡, 27·2 A. per mm.

The three dotted lines marked H_{11}, H_{21} and H_{31} passing through the origin of the co-ordinate system represent, as explained in an earlier publication[4], the theoretical maximum displacements corresponding to the light emitted by the neutral hydrogen atoms derived from H_1^+, H_2^+ and H_3^+ particles that had fallen through the full voltage applied to the discharge tube. The maximum displacements at each discharge potential used were measured from spectra obtained with graded times of exposure. Great care was taken to eliminate the many-lined spectrum while measuring the respective maximum edges of the Doppler bands.

Starting from a discharge potential of 0·5 kV. and going up to about 2·5 kV., two strips corresponding to H_{21} and H_{11} were measured. The H_{21} strip is not very distinct in this region. Beyond 3·0 kV. and in practice above 2·5 kV., however, the H_{21} strip appeared with increasing intensity, while the H_{31} strip was faint and could not be measured. This discharge potential, namely, 2·5 kV., corresponds in the present investigation to a pressure of 0·09 mm. in the discharge space. For pressures lower than 0·09 mm. the discharge potential would increase beyond 2·5 kV. Hence 0·09 mm. is the minimum pressure below which the H_{21} strip becomes faint. A comparison of the intensities of the H_{21} and H_{11} strips showed that at about 1,120 volts discharge potential they are of the same intensity.

The above results are in good agreement with the observations made by Hornwell[5] using the method of collisions. They differ, however, in certain respects, a discussion of which, along with the details for the rest of the Balmer lines studied, will be reserved for publication elsewhere.

The above work was done in the Positive Ray Laboratory of the Benares Hindu University, and I am grateful to Dr. B. Dasannacharya for his interest in the investigation.

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Vacuum Sublimation of Ice in Bulk

An ice sublimation or freeze-drying process will have maximum rate of vaporization per unit exposed area of frozen product at a specified temperature if the following conditions are satisfied: (i) The vapour pressure of ice sublimed on the condenser is negligible compared with ice at the product temperature. (ii) The condensing and product surfaces have a uniform and minimum separation. (iii) The permanent gas (usually air) pressure in the product-condenser interspace is a minimum. (iv) Mechanical obstruction (in the form of radiation shields, sterile caps, etc.) to vapour transfer from product to condenser is a minimum. (v) The product is of uniform and minimum thickness. The first four conditions follow from kinetic considerations and ensure that reversed vapour transfer, length of vapour path, and obstruction to vapour transfer are a minimum. The last condition is a consequence of the increase of drying-time with product thickness.

To satisfy these conditions, a plant has been constructed consisting of a tray and condenser within a 500-litre vacuum chamber. The tray and condenser are in the form of rectangular, stainless steel plates, 46 cm. × 76 cm., and are identical apart from the upturned edges of the tray. The horizontal plane of the condenser is 6 cm. above that of the tray. The condenser is maintained at − 80° C. and the tray at any required temperature between − 30° C. and + 60° C. The chamber is evacuated by means of an oil diffusion pump and backing pump, the vacuum line being baffled by the upper surface of the condenser in order to eliminate contamination of the condensing surface by diffusion pump oil and to reduce the mass of water vapour taken through the pumps. Product and other temperatures are measured by means of embedded thermocouples.

Up to 6 litres of liquid to be dried are poured into the tray and frozen to − 25° C. in 30 min. by contact with this surface at − 30° C. The condenser is now cooled to − 80° C. and the chamber evacuated to a permanent gas pressure of one micron of mercury. As in other drying plants[1,2], the tray or equivalent temperature is raised as drying proceeds in order to maintain a maximum vaporization-rate consistent with the nature and condition of the product.

The drying process may be divided into two clearly defined phases. The first is characterized by the uniform recession from the product surface of the horizontal plane of separation between upper partially dry product and lower frozen product. The plane recedes by approximately 1·5 mm. per hour, and this is equivalent to a constant vaporization-rate of 34 μgm. per sq. cm. per sec. This phase terminates when the receding plane of separation coincides with the tray surface. At this stage, 15 per cent of the original liquid bulk remains in the form of isolated ice crystals distributed throughout the partially dried product. Commencement of the second phase of drying is therefore characterized by a rapid fall in the rate of vaporization. The product temperature is now raised from − 10° C. to + 25° C. in 2–3 hours and maintained at this temperature for the remainder of the drying cycle. This is achieved by control of the tray temperature, a final product-temperature of + 25° C. requiring a tray temperature of + 50° C. Two additional hours per litre of initial volume are required for the complete vaporization of these ice crystals. Thus, for most biological fluids, a total drying time of 4 hr. per litre is required to obtain a residual moisture content of less than 1 per cent by weight. Lower moisture contents may be obtained by secondary desiccation over phosphorus pentoxide. At the conclusion of the drying cycle, the underside of the condenser supports an ice sheet of uniform thickness which consists of a mass of ice crystals orientated with the long axis normal to the condenser surface. The bulk density of this ice sheet is 0·7 gm./cm.³. No ice forms on the upper surface of the condenser.

It may be shown[3] that the maximum rate of vaporization from an ice surface into a perfect vacuum is given by the equation $G_{max.} = 0{\cdot}244 \frac{\alpha P_s}{\sqrt{T}}$ (gm. per sq. cm. per sec.); where P_s mm. mercury is the saturated vapour pressure in equilibrium with the ice surface at absolute temperature T and α is the condensation coefficient. Tschudin[4] has tested this equation for values of T between − 60° C. and − 86° C. and finds the condensation coefficient to be 0·94 ± 0·06. Observations by Alty[7] on water drops lead to a condensation coefficient of 0·04 between + 4° C. and − 8° C. If the equation is applied to vaporization from the plane of separation during the first phase of drying (that is, at product-temperatures between − 10° C. and − 30° C.) the mean condensation coefficient is 0·0024. This is equivalent to the statement that the theoretical vaporization-rate, on the assumption of a unit condensation coefficient, is 420 times greater than the experimental value. However, high rates of vaporization may lead to appreciable surface cooling and consequently a greater condensation coefficient. It is also probable that

vapour transfer is obstructed by molecular collisions in the tray-condenser interspace. In view of the proportionality between initial volume and drying time, the obstruction to vapour transfer by the layer of partially dry product above the plane of separation is likely to be of secondary importance. The influence of these factors on vapour transfer is under further investigation.

Two freeze-drying plants due to Greaves and Adair[1] and Greaves[2], in which the average length of vapour path is ten times greater than in the tray drier here described, yield average vaporization-rates between 5 and 10 μgm. per sq. cm. per sec. These values are to be compared with the average vaporization-rate of 20 μgm. sq. cm. per sec. given by the tray drier under sterile conditions and a similar product-temperature cycle. It is interesting to observe that curves published by Greaves and Adair[1] for the drying of 5 litres of serum in 100 hr. support the postulation of two phases of drying. These curves show that the first phase of drying required 30 hr. at a product-temperature of about − 20° C. In this time 59 per cent of water had been removed, and on our calculation this is equivalent to a vaporization-rate of 10·9 μgm. per sq. cm. per sec. The average vaporization-rate over the total drying time of 100 hr. was 5·6 μgm. per sq. cm. per sec.

The tray drier was designed three years ago, and, with minor sterile modifications, has been used in the intervening period to dry human fibrin foam[3], human and cow's milk[4], sodium and calcium penicillin solutions, cyst fluid and other biological fluids. An industrial-scale drier based on this design and containing five interleaved tray-condenser units in each vacuum chamber has been erected by Imperial Chemical Industries, Ltd., for the freeze-drying of penicillin solutions.

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Intrinsic Electric Strength of Polythene

The work of Austen and Pelzer[1] on the use of recessed specimens for measurement of the electric strength of dielectrics suggested that with specimens of this type experimental verification of the theories of breakdown developed by Frohlich and von Hippel[2,3] might be possible. Frohlich's recent extension[4] of his theory predicts: (*a*) that the electric strength should be independent of thickness until the latter approaches the order of the electronic mean free path, when the electric strength should increase with decreasing thickness; and (*b*) that below a certain critical temperature the electric strength should either increase with temperature or be nearly

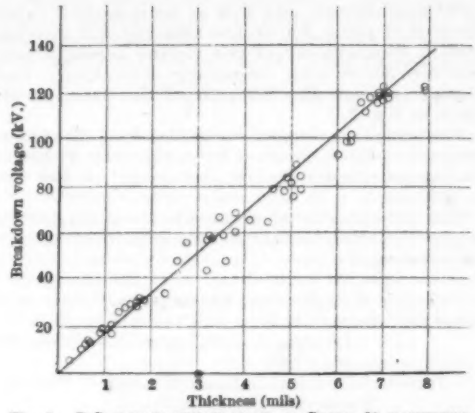

Fig. 1. D.C. breakdown voltage of Grade 20 polythene at 20° C.

independent of temperature, while above this critical point the electric strength should decrease with increasing temperature according to the relation $\log F \propto \frac{1}{T}$, where F is electric strength and T is absolute temperature.

Recent determinations of the D.C. electric strength of polythene show some measure of agreement with these predictions. For specimens varying in thickness from 0·0005 in. to 0·008 in., the breakdown voltage was observed to be an approximately linear function of thickness (Fig. 1). The mean breakdown stress derived from such a series of measurements was found to be substantially independent of time of application of voltage, radius of curvature of the specimen recess, polarity of the recess electrode, and the nature of the ambient medium. There was a small but significant difference between the value obtained with graphite electrodes and that obtained with silver electrodes, but otherwise it seems reasonable to assume that the mean breakdown stress so measured is an intrinsic property of the dielectric material.

The variation of the breakdown stress of polythene with temperature (Fig. 2) indicates that the critical temperature is about 25° C. The difference in shape between the experimental and theoretical curves is probably associated with the reduction in the crystallinity of polythene with increasing temperature. Frohlich's theory predicts that, as the crystallinity decreases, the critical point will be displaced to a

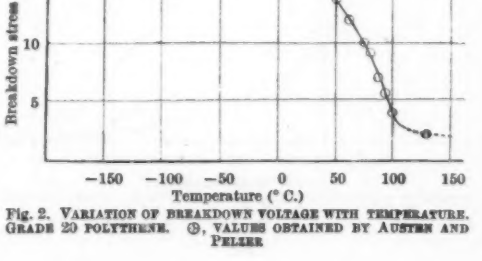

Fig. 2. Variation of breakdown voltage with temperature. Grade 20 polythene. ⊕, values obtained by Austen and Pelzer

lower temperature, and that at temperatures below the critical point the electric strength will increase. Such a displacement of the electric strength temperature curve with decreasing crystallinity may possibly explain the S shape of the experimental curve in Fig. 2.

There is satisfactory agreement between the present results and those obtained by Austen and Pelzer on similar specimens of polythene at 20°, − 80° and − 195° C.

The experimental work involved was carried out in the Electrotechnical Laboratories, University of Manchester.

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Determination of Limit of Proportionality of Wires

In connexion with the determination of the limit of proportionality of cold-drawn wire, the following technique, which so far as we are aware is novel, has been used with success. The wire itself is employed as a 'strain gauge', the increase of electrical resistance as the load is increased being measured. The electrical contacts near the grips of the tensile testing machine were connected to a Cambridge dial bridge on which the resistance was measured; gauge-lengths of 50 or 100 cm. were employed.

Typical curves are shown in Figs. 1 and 2, which refer respectively to mild steel containing 0·08 per cent of carbon and a nickel–copper alloy. In Fig. 1 the elastic range is clearly shown, the curve following very closely that obtained in the normal stress-strain test right up to the point of fracture. Fig. 2 shows the hysteresis loop obtained, both by the normal and the new method.

A point of some interest, for which, as yet, no

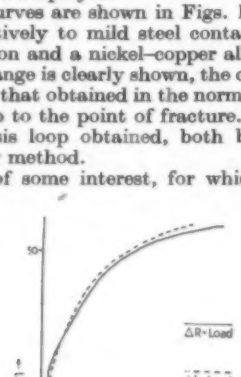

Fig. 1

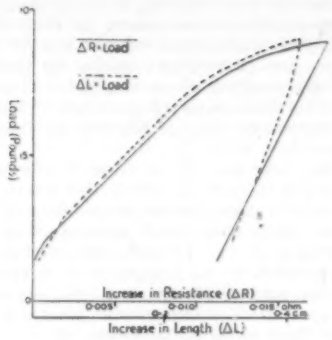

Fig. 2

explanation can be given, is that with some materials a distinct break has been observed in the stress-resistance curve at loads which will carry the material well into the plastic range, a point which is receiving further attention.

The simplicity of the new technique, and its ready adaptability to the testing of wire in particular, seemed to justify this short communication.

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The Problem of Classification and Distance Between Two Populations

The problem of specifying an individual as a member of one of many populations, and the classification of a number of populations themselves in some significant system based on the configuration of various characteristics, are of great importance in anthropological and biological research. We may find a collection of skulls with unspecified sexes, and the problem faced by an anthropologist is assigning proper sex to a skull. Judgment based on mere anatomical appreciation of a skull may not be altogether wrong, but is subject to criticism especially when objective methods are available. This problem has been solved by Fisher's *discriminant function*. If we have a collection of skulls grouped according to specified populations, the problem is to arrive at constellations of populations such that any two members of a constellation are closer to one another than any two belonging to different constellations. This problem can be solved by Mahalanobis's *generalized distance*.

In this communication an attempt has been made to present solutions satisfying a logical set of requirements to these problems of classification. The probability distributions considered are quite general and the results arrived at are capable of simple interpretation. Incidentally, this supplies a logical appreciation of intuitive tools introduced by Fisher and Mahalanobis.

Classification with assigned characters in a population. There are two populations π_1 and π_2 characterized by probability densities $f_1(x_1 \ldots x_p ; \theta_1 \ldots \theta_l)$ and $f_2(x_1 \ldots x_p ; \theta_1' \ldots \theta_l')$, where x's are variables and θ's are parameters. We shall denote them by ${}_pf_1$ and ${}_pf_2$, where p stands for the number of characters used, or simply by f_1 and f_2. If an individual

can be represented by an ordered set of measurements on p characters or a point in a space of p dimensions, then the problem requires a division of space into mutually exclusive regions R_1 and R_2, and the rule of procedure of assigning the individual to π_1 if he belongs to R_1, and to π_2 otherwise. Let the probabilities of an individual I belonging to R_1 and R_2 when he is from π_2 and π_1 respectively be denoted by

$$P(I \subset R_1/\pi_2) = \alpha_1, \; P(I \subset R_2/\pi_1) = \alpha_2;$$

so that these supply the frequencies of errors in classification. If we suppose $\alpha_1 = \alpha_2 = \alpha$, then a logical requirement is that the regions should be chosen such that α is minimum. The problem is solvable by a lemma due to Neyman and Pearson, and the regions are given by $f_1 \geqslant \lambda f_2$ and $f_1 \leqslant \lambda f_2$ respectively, where λ is chosen such that $P(I \subset R_1/\pi_2) = P(I \subset R_2/\pi_1)$, the common value being the minimized value of α.

In some problems, we may require the regions such that $\alpha_1 + \alpha_2$ is minimum, in which case the regions R_1 and R_2 are defined as $f_1 \geqslant f_2$ and $f_1 \leqslant f_2$ respectively; that is, the individual is assigned to one population or the other according to the likelihood ratio of these two hypotheses.

In other problems we may require that α_1 and α_2 should have assigned values smaller than the values obtained above. In this case the space has to be divided into three regions R_1, R_2 and D, such that an individual belonging to D remains unclassified. A logical requirement of the problem, then, is to choose these regions such that the unclassified percentage of individuals in a collection with an unspecified proportion of mixture of members belonging to π_1 and π_2 is minimum. The regions R_1, R_2 and D are given by

$$\frac{f_1}{f_2} \geqslant \lambda_1, \frac{f_1}{f_2} \leqslant \lambda_2 \text{ and } \lambda_2 \leqslant \frac{f_1}{f_2} \leqslant \lambda_1, \text{ respectively,}$$

where λ_1 and λ_2 are chosen such that

$$P(I \subset R_1/\pi_2) = \alpha_1, P(I \subset R_2/\pi_2) = \alpha_2,$$

where α_1 and α_2 are assigned.

In the third case discussed above, the region of doubtful classification has been introduced to keep the wrong classifications at a desired level. If the problem admits the measurement of a large number of characters, we can in some circumstances make the frequencies of doubtful classification as small as possible. A sequential procedure is available, by following which the proportion of wrong classifications is kept at a desired level without making use of a large number of characters. This test has been derived from Wald's sequential theory by suitable extensions to multivariate analysis. Starting with p characters we define the regions ${}_pR_1$, ${}_pR_2$ and ${}_pD$ by

$$\frac{{}_pf_1}{{}_pf_2} \geqslant \frac{1-\alpha_2}{\alpha_1}; \quad \frac{{}_pf_1}{{}_pf_2} \leqslant \frac{\alpha_2}{1-\alpha_1} \text{ and}$$

$$\frac{\alpha_2}{1-\alpha_1} < \frac{{}_pf_1}{{}_pf_2} < \frac{1-\alpha_2}{\alpha_1}$$

respectively. If an individual belongs to ${}_pR_1$ or ${}_pR_2$, the conclusions are the same as before. If he belongs to ${}_pD$, we take measurements on *one* or more characters, and construct these regions corresponding to $p+1$ or $p+r$, and so on. The details of this test have been worked out in the case of multivariate populations of the normal type, and will be given elsewhere.

Distance between two populations. If we have a mixture of individuals belonging to π_1 and π_2 in equal proportion, then following the two procedures given above, the proportions of correct classifications are $1-\alpha$ and $1-\frac{\alpha_1+\alpha_2}{2}$. We may take the first or the second as the distance between two populations π_1 and π_2. These are capable of simple interpretation, as α and $(\alpha_1+\alpha_2)/2$ stand for overlapping individuals who may be wrongly classified. It is interesting to observe that the distances defined by the above expressions obey the triangle law, namely, the sum of distances of a population from two different populations is not less than the distance between the two other populations. The distances defined are explicit functions of Mahalanobis's D^2 in the case of multivariate normal populations.

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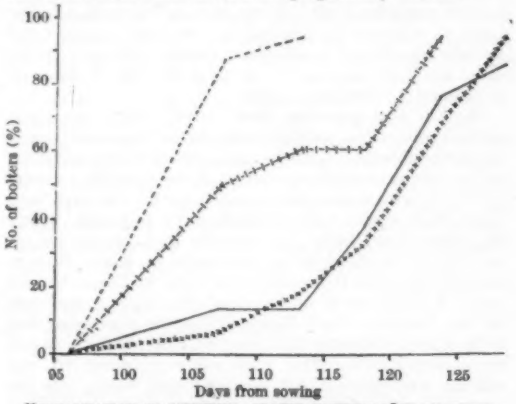
Vernalization of Lettuce

Gray[1] and Simpson[2] have both reported experiments on the vernalization of lettuce, and these observers agree that low (2–8°) temperature treatment of the swollen seeds for varying periods, while not affecting the date of heading, reduces the period for which the plants remain in the heated stage and accelerates flowering by fourteen to twenty days. Experiments carried out here indicate the importance of the timing of these vernalization treatments.

Four sets of Feltham King lettuce (a long-standing variety of summer cabbage lettuce) were sown outdoors on April 8. One set of seed (*S*) was soaked for twenty-four hours before sowing, and a second set (*SX*) for seventy-two hours, by which time germination had begun and the radicles emerged. Two other sets (*V* and *VX*) were similarly soaked, and after soaking held at 0–4° C. for twenty-four days before sowing. All four sets were sown together, all germinated and emerged from the soil satisfactorily and at apparently the same rate, and came to the hearting stage together. They showed, however, considerable differences in the rate at which 'bolting' occurred. In no set was any sign of bolting evident before July 20, and the percentage of bolters in each set after this date is shown graphically below.



Vernalization of lettuce: graphs continued to maximum values obtained

– – –, *V*; —I—I—I, *VX*; ——, *S*; x x x, *SX*

That 100 per cent of bolters were never found was due to a small attack of *Botrytis cinerea*. The difference in appearance of the four sets of plants was most striking on July 30. On this date the majority of *V* plants were 45–60 cm. in height, and the *VX* plants 15–18 cm., while a few *S* and *SX* plants were just showing only the first signs of 'bolting'. Actual flowering dates were for the *V* plants Aug. 28, *VX* plants Sept. 2 and *S* and *SX* plants Oct. 1. The vernalization treatment of the swollen seed accelerated flowering by thirty-one days. This great acceleration was probably due in part to unfavourable weather during September, retarding the flowering of the *S* and *SX* plants. The chief point of interest is that the vernalization treatment given after radicle emergence had occurred was so much less effective than the treatment commenced after the seed had swollen for only twenty-four hours and before germination had begun.

A rather severe attack of *Botrytis* on a similar series of Webb's Wonderful lettuce was not sufficient to mask similar trends with this variety.

These observations serve to emphasize the importance of the timing of any vernalization treatments. They may not be without their practical significance. Early sowings of a number of crop plants (for example, beet, turnip, celery[2,4], etc.) are especially prone to flower prematurely, and this may be due in some cases[4] to a vernalizing effect on the swollen or germinated seed, or on the seedlings, of naturally experienced low soil or atmospheric temperatures in early spring. In so far as the effect is one on the swollen seed and not on the young seedling, the possibility of avoiding these undesirable effects by the sowing of already germinated seed is opened up.

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Prevention of Oil Shock in the Orchard

The use of a highly refined petroleum oil for application to orchard trees as an insecticide and acaricide is firmly established as a valuable pest-control treatment with citrus, but its use on deciduous trees in summer is limited by the fact that, under certain ill-defined conditions, severe leaf and fruit-drop has been known to occur following the use of a 'summer' petroleum spray.

During the seasons 1944, 1945, 1946, we have carried out field experiments in commercial apple orchards designed to determine whether the addition of the plant-growth regulator alpha naphthyl acetic acid to a white-oil spray would prevent the leaf- and fruit-drop which might otherwise be induced. Until this season we failed to produce leaf- or fruit-drop by the application of oil in trials in Kent, Sussex and Essex; but this year, on a farm in Essex, severe drop of both leaves and apples did occur in the case of the variety Cox's Orange Pippin after spraying with a white-oil emulsion used at 1 per cent (0·75 per cent actual oil). The base oil conformed to the official specification for horticultural white oils for orchard use. On adjoining plots alpha naphthyl acetic acid was added to the diluted oil emulsion as sprayed, so that the concentration of the plant-growth regulating substance was 10 parts per million. The spraying was carried out on June 19, 1946, the variety being Cox's Orange Pippin with Worcester Pearmain as pollinator. On August 28, 1946, a count of the fruits remaining on the Cox trees was made, and the average fruits per tree were as follows:

Control—unsprayed trees	44·2
White-oil spray alone	6·0
White-oil spray plus alpha naphthyl acetic acid	51·9

In this case, therefore, the alpha naphthyl acetic acid, a material which is commonly used for the prevention of pre-harvest drop of apples and pears, applied simultaneously with an oil spray, has modified or prevented the shock due to the application of oil and thereby prevented leaf- and fruit-drop.

We regard this result as important since a summer application of white oil to foliage is probably the best method of controlling the serious pest red spider mite (*Oligonychus ulmi* C. L. Koch) on apples, and hitherto oil has not been widely used for this purpose in Great Britain because of the risk of causing leaf- and fruit-drop.

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Gaseous Sulphur Dioxide and Sodium Bisulphite as Preservatives of Citrus Concentrates

Differential preservative efficiency between gaseous sulphur dioxide and sodium bisulphite, observed in citrus concentrates, became of practical significance during the War due to the difficulties in obtaining an adequate supply of gaseous sulphur dioxide in Palestine. Investigating the effect of acidity on the efficiency of various preservatives, Rahn and Conn[1] found that yeast is checked only by molecular H_2SO_3, and not by dissociated ions HSO_3' or SO_3''. According to Downer[2], quantities ranging between 2,000 and 2,500 p.p.m. sulphur dioxide are necessary for citrus juice concentrates (4 : 1), and even more are required for higher concentrations, in order to prevent fermentation. This has been explained by him as due to the fact that part of the sulphur dioxide combines with the aldehyde group of the sugar contained in the juice, leaving only part free to act as preservative.

In our experiments, increasing amounts of sodium bisulphite and parallel gaseous sulphur dioxide have been added to concentrated citrus juice (6 : 1), inoculated with a known number of wine yeast. The test mixtures, which have been examined periodically during three months, showed the bisulphite to be at least 30–40 per cent more efficient than sulphur dioxide.

The minimum quantity of sodium bisulphite to be added to the concentrate, in order to prevent fermentation, has been found by us to range between 1,000 and 1,200 p.p.m., equivalent to 600–700 p.p.m. sulphur dioxide, while 800–1,000 p.p.m. gaseous sulphur dioxide, equivalent to 1,300–1,600 p.p.m. bisulphite, are necessary to produce the same effect.

No significant difference has been observed in the *p*H of citrus juice concentrate containing either of the two preservatives. Both of them also show the same vitamin C content.

It is to be noted that tests with 1,000 p.p.m. sulphur dioxide gas (or 1,300 p.p.m. sodium bisulphite), and more, preserved the original colour almost to the very end of the experiment (more than three months), the test being carried out at 25–28° C. Control tests and citrus concentrates containing less than 1,000 p.p.m. sulphur dioxide darkened progressively with storage.

It seems to us that larger amounts of preservatives are required for colour preservation than for microbiological protection. The limit for the former has been found to be 1,000–1,200 p.p.m. sulphur dioxide gas, or 1,200–1,350 p.p.m. bisulphite solution (equivalent to 700 p.p.m. sulphur dioxide).

The relative efficiency of gaseous sulphur dioxide and sodium bisulphite solution may be explained by the different behaviour of the two forms of preservatives when dissolved in the citrus juice concentrate[3].

These experiments have been carried out in the Department of Biological and Colloidal Chemistry, Hebrew University, Jerusalem, with the generous co-operation of Prof. A. Fodor, director of the Department. We acknowledge with thanks the interest taken by the Scientific Advisory Committee, War Supply Board, Government of Palestine, which has also sponsored this investigation.

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Vitamin Content of Tubercle Bacilli

MANY chemical compounds which inhibit the growth of certain bacteria are structurally related to compounds which are growth stimulators for the same bacteria. This relationship makes of interest the vitamin content of pathogenic bacteria grown on vitamin-free media, since this may give a clue to the structure of compounds which are important in the metabolism of the micro-organism under study and indicate a starting point for the synthesis of possible growth inhibitors. Thus, Ekstrand and Sjögren have reported on the production of *p*-aminobenzoic acid by the tubercle bacillus[1].

Recently we have had occasion to assay a tubercle bacillus culture for several vitamins by microbiological methods. The culture was an H37Rv strain of virulent human type tubercle bacilli (supplied by Dr. Guy P. Youmans, Northwestern University Medical School, Chicago) which had been grown for 21 days on Proskauer – Beck medium. Determinations were made on the carefully suspended whole culture and on the clear filtrate after removing bacterial cells by centrifugation. The results are indicated in the table.

Vitamins determined	Culture filtrate* (γ/c.c.)	Whole culture† (γ/c.c.)
Vitamin Bc	0·05	—
p-Aminobenzoic acid	—	0·0216
Pantothenic acid	1·04	—
Riboflavin	0·2	1·5
Nicotinic acid	37	61
Biotin	0·03	0·057

* Autoclaved 30 min. at 15 lb. pressure before assaying.
† Autoclaved 30 min. at 15 lb. pressure in *N* sulphuric acid before assaying.

A sample of the basal medium was also assayed for the vitamins indicated. Negative results, indicating less than 0·002 γ per c.c., were obtained for all except nicotinic acid. The amount of nicotinic acid found was 0·071 γ per c.c.

Of interest in these results are the rather high content of nicotinic acid and the low content of vitamin Bc and *p*-aminobenzoic acid. Ekstrand and Sjögren[1], using a chemical method of assay, also found only a small amount of *p*-aminobenzoic acid in tubercle bacilli. This is in contrast to a value of 0·63 γ *p*-aminobenzoic acid per c.c. which we recently obtained for a 17-hr. culture of *E. coli*.

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Antibacterial Titre in Wood-destroying Fungi

FROM exploratory surveys of the production of bacteriostatic substances by wood-rotting fungi both in Great Britain and in the United States, it appears that the authors, Wilkins[1] and Robbins *et al.*[2], have tested the antibacterial activity of the metabolism-solution periodically up to a maximum of 30 days and 22 days respectively, and that their test-organisms have always been *Bacterium coli* and *Staphylococcus aureus*. On the basis of my experiences stated below, I suggest that: (1) this period of test should be extended, and that (2) some other organisms should also be employed as test-organisms from time to time.

In the course of my work on the antibacterial activity of 'polyporin' from a wood-destroying fungus, *Polystictus sanguineus*, I[3] have observed that the antibacterial titre persists for a much longer time (in some cases more than three months), with periodic rise and fall of the titre, and that the activity which appears very early in the course of a week or so goes down soon and does not seem so stable as the one which appears later. For example, in an inoculated flask where the composition of the medium was of $MnSO_4$, $FeSO_4$, pea seed-extract, KH_2PO_4 and 4 per cent glucose, the antibacterial activity of the fungus which appeared on the ninth day disappeared on the eleventh, while the activity appearing on the fifteenth day continued until the thirtieth, and the activity reappearing on the sixty-fifth day continued until the eighty-sixth; in another case I have a record of continuing activity from the seventieth to the ninety-eighth day, with five rises and falls from the initial start. Kent[4] has distinguished two kinds of substances in the metabolism solution, one as staling substances which appear earlier in the course of growth of the organism and are not very stable, and the other as inhibitors which are fairly stable and are slow in appearing in culture media. It has been further observed that a fungus inactive against *Staph. aureus* and *B. coli* forms substances antibiotic against other organisms (typhoid, cholera, etc.).

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Sex in *Melandrium*

THE development of stamens in pistillate plants of *Melandrium* under the influence of *Ustilago violacea* (Pers.) Fuckel is well known. Recently, this action has been simulated by treatment of plants with the animal hormone testosterone, while the reverse change has been caused by œstrone[1,2]. None of the authors responsible for accounts of the reversal, whether natural or artificial, has remarked upon the fact that, when such a change from the pistillate to the staminate condition occurs, some characters of pistillate plants are replaced by those typical of staminate plants while others are not. Thus, the copious branching and diminution in size of the leaves which is produced in the region of the inflorescence, and the grouping of the flowers into more or less sessile clusters, all of which are characteristics of staminate plants, appear after infection. On the other hand, the calyx retains the inflated shape characteristic of pistillate plants and, although infection of originally pistillate and staminate plants reduces the length of the calyx-teeth, they retain the characteristic difference in shape, and those of the pistillate plants remain the longer. These characters are seen best in *M. album*, where the differences between pistillate and staminate plants are more extreme.

It appears that the differences in branching are secondary sexual characters while the differences in calyx-characters are completely sex-linked. One of the purposes of this note is to indicate the possibilities which such hormone studies hold out in discriminating between two otherwise inseparable types of character.

Infection by *Ustilago violacea* or, according to Löve and Löve[1,2], the application of the *single* chemical substance testosterone, can perform the *dual* function of promoting the formation of stamens and suppressing the formation of pistils. On the other hand, Westergaard[3,4] has postulated that these two functions are performed, normally, by two separate sets of genes on the *Y*-chromosome, and has produced considerable cytological and genetical evidence in support of this idea, including the removal of the 'female-suppressors', in which case the plants lacking them produce both stamens and pistils.

One modern tendency (see review by Löve and Löve[2]) is towards the assumption that the normal formation of staminate flowers is due to the genically controlled production of a substance resembling testosterone. This does not preclude the possibility of the simultaneous production of 'œstrone' in quantities insufficient to affect the morphology. It is not easy to reconcile this view with the *two specific* actions which Westergaard postulates for the sets of genes. This difficulty is important because Westergaard has made far-reaching deductions concerning the evolution of dioecism from his results.

It should be pointed out, however, that in interpreting the genetical data the idea of 'female-suppressors' in *Melandrium* has been introduced only because the effect of the *removal* of the genes concerned is to cause pistil development. Alternatively, it might be argued that a concentration of 'testosterone' just sufficient to promote the formation of stamens but insufficient to suppress pistil-formation might be produced under the influence of one set of genes, while an additional production of 'testosterone' caused by the other set of genes would induce the abortion of the pistil. Thus, the two sets of genes could have the same action and neither be specifically a 'female-suppressor' nor a 'male-promoter'. This view is supported by the fact that purely pistillate plants, when infected by *Ustilago violacea*, produce well-formed stamens, while the abortion of the pistil varies in extent and is never complete. A similar impression is gained from the diagrams by Löve and Löve[2] showing the effect of treating pistillate plants with testosterone.

In *Melandrium* the structure of the *X*-chromosome is not so well known as that of the *Y*, so that 'male-suppressors' or 'female-promoters' upon it are not known as yet.

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Sweating in Sheep

DURING investigations on the humidity of the fleece atmosphere carried out in the summer of 1946, certain sheep were found to have a consistently higher relative humidity (70–90 per cent) close to the skin than at points farther out in the thickness of the fleece (25–50 per cent); humidity measurements being made with cobalt chloride papers, prepared as described by Solomon[1]. Strips of cobalt chloride paper were placed vertically in the fleece so that one end of each strip rested on the skin and the other lay about 1 in. away from the skin. Humidity differences were measured between the two ends of single papers so placed. In one healthy, undipped sheep, the high humidity found at the base of the fleece was confirmed by placing close to the skin *Lucilia sericata* (Mg.) eggs incubated to within half an hour of hatching; other eggs from the same batch were placed in the same part of the fleece, but one inch away from the skin. The eggs near the skin hatched immediately, indicating a humidity of at least 80 per cent, as shown by the work of Davies and Hobson[2]. The larvæ survived in this position and established a strike without any addition of moisture. Eggs placed one inch from the skin did not hatch, indicating a lower humidity at that point. The limiting factor for strike on this and other sheep used appeared to be the non-attraction of blowflies to oviposit on them. The existence of a population of gravid blowflies in the vicinity was shown by attracting flies to oviposit on some of the sheep, using the technique of Hobson[3].

It is concluded from the above evidence that certain sheep sweat to an extent sufficient to maintain humidities at the base of the fleece suitable for the development and survival of blowfly eggs and young larvæ. Under similar weather conditions, other sheep were found to have fleeces too dry throughout for strikes to develop successfully.

It was not clear from the above observations how far such sweating varied and depended on the activity of the sheep. Freney[4] attempted to find if sweating occurred in sheep after running; he found that the weight of moisture in wool samples from the base of the fleece did not increase after sheep had been run in hot weather. The following experiments were made, therefore, using cobalt chloride papers as described above, to discover how far moisture

conditions at the base of the fleece depended on activity. The accompanying table gives readings of fleece atmosphere humidity for a single dry-fleeced Herdwick × Swaledale wether, 18 months old, before and after running for 10 minutes around a field on a sunny afternoon in August 1946 (air temperature, 16° C.).

% R.H. FLEECE ATMOSPHERE, AS MEASURED BY COBALT CHLORIDE PAPERS
(Papers reading 20–40% R.H. were not accurately read, but are recorded as 'below 40%')

Position in the fleece	15 min. before running		30 min. after running		2 hours after running	
	Skin surface	1 in. off the skin	Skin surface	1 in. off the skin	Skin surface	1 in. off the skin
Withers	below 40	below 40	55	48	below 40	below 40
Tailhead	below 40	below 40	57	—	below 40	—
R. crutch.	below 40	below 40	62	62	45	—

It is seen that after the sheep was run the relative humidity at the base of the fleece rose, clearly indicating that an increased rate of sweating had occurred. Further, the fall in humidity after two hours indicates that the effect was transitory. The experiment was repeated four times on the same sheep on different days with similar results. A single experiment on a Swaledale ram lamb also showed a transitory rise in basal fleece humidity after running.

The full results of fleece humidity measurements by cobalt chloride papers will be published elsewhere.

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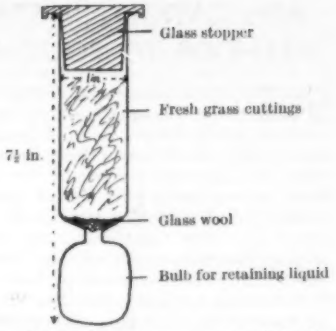
Activity of Thermophilic Bacteria in Composts of Fresh Green Material

During the course of an investigation on the microbiology of composts made from fresh grass cuttings, it was noticed that a dark brown liquid oozed from the material. A large volume of this liquid is produced, and it is very rich in ammonia nitrogen. Under normal conditions of composting it would be lost, and therefore some knowledge of its production is of considerable interest. The liquid first appears when the compost is at a temperature of 65°–55° C.

It has been found possible to reproduce the above phenomenon on a small scale in the laboratory. The arrangement illustrated has proved particularly satisfactory. Series of these tubes can be incubated in a thermostatically controlled water-bath at 65° and 55° C. From the results of experiments with these tubes, it is suggested that this dark brown liquid may be formed through the degradation of organic nitrogen to ammonia by thermophilic bacteria, and the subsequent hydrolysis of chlorophyll under the alkaline conditions produced by this ammonia.

At the temperatures mentioned above, a thermophilic bacterial flora has been found to develop both in the compost and in the tubes. In the compost it can be seen as a white coating covering the cuttings, particularly in the upper layers. Also the dark-coloured liquid produced in the compost and in the laboratory experiment is in both cases very rich in thermophilic bacteria. It was thought that there might be some relationship between the activity of the thermophilic flora and the production of the liquid. The following evidence supports this view.



(*a*) Fresh grass cuttings sterilized with 1/1,000 corrosive sublimate when incubated for five days at 65° C., followed by eight days at 55° C., failed to produce the typical dark brown liquid. The grass also retained its green colour and showed no evidence of decomposition.

(*b*) Unsterilized fresh cuttings under the same conditions of incubation gave the liquid, the grass changing its colour from green to brown, and obviously undergoing decomposition.

(*c*) Many isolates of the thermophilic flora have been made from both the compost and the tubes. True and facultative thermophilic bacteria have been found to be present. They are rod-shaped, spore-forming bacilli and are very strong ammonifiers. They do not attack chlorophyll in culture media.

(*d*) Chemical analyses have shown a marked increase in ammonia nitrogen when fresh grass is incubated at 65° C. This does not occur when the cuttings have been sterilized.

It would appear, therefore, that the thermophilic flora attacks organic nitrogenous material of the compost, liberating ammonia. As a result of this, it would be expected that conditions in the tubes and compost would become alkaline. Measurement of *p*H shows this to be the case.

It is well known that chlorophyll can undergo changes from green to brown when hydrolysed under alkaline conditions. In view of this, it seemed possible that the explanation of the dark brown colour might be connected with the production of alkaline conditions. Moreover, the thermophilic bacteria isolated did not attack chlorophyll in culture media.

The following experiment supports this hypothesis. Tubes with sterilized grass were set up, and into the bulb of each tube a few c.c. of strong ammonium hydroxide were introduced. The tubes were then incubated at 65° C. In a few days the grass began to change from green to brown, and the liquid which collected in the bulbs was very similar in appearance to that produced during composting.

Full details and further information on the microbiology of grass composting will be published in due course.

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APPLICATION OF STATISTICAL METHODS TO FOOD PROBLEMS

STATISTICAL analysis and the logic of inductive inference are taking a part of increasing importance in many branches of scientific research and technology. Evidence of this is provided by the wide range of scientific journals and meetings in which there is frequent discussion of points of statistical technique. A few years ago, the statistical aspect of problems under consideration at scientific meetings was seldom mentioned; to-day there is a welcome tendency for societies to keep their members informed of developments in statistical methodology important to their field of study. At a well-attended joint meeting of the Society of Public Analysts and Other Analytical Chemists and of the Food Group of the Society of Chemical Industry, held on December 4, papers on "The Application of Statistical Methods to Food Problems" were read and discussed. The president of the Society of Public Analysts, Dr. G. W. Monier-Williams, was in the chair.

An introductory paper, "The Inevitability of Statistics", was given by Mr. D. J. Finney (University of Oxford). He said that since many types of measurement, in the physical as well as in the biological sciences, are not perfectly reproducible in repeated trials, the interpretation of numerical data is often impossible without using, explicitly or implicitly, statistical concepts. Even the calculation of a mean of several observations is a statistical operation, and from the dispersion among individual values the reliance to be placed on the mean may be assessed. A chemist should therefore have some knowledge of statistical principles, even though he need not concern himself directly with the computation of statistical analyses. Mr. Finney asked for close co-operation between analytical chemists and statisticians in the planning of investigations, as well as in the examination of results, since this would tend to increase the information obtainable from a specified amount of experimental work. He instanced the sampling of foodstuffs for the estimation of a constituent, including quality control with the aid of routine sampling, the design and analysis of experimental work in food production and in laboratory testing, and biological assay, as examples of the many ways in which statistical science can help in the elucidation of food problems.

Mr. W. B. Adam (Fruit and Vegetable Preservation Research Station, Campden) spoke on "The Use of Statistical Methods in Research on Food Canning". He emphasized the need for good experimental design and sound statistical technique in research into food technology; since the raw materials are very variable in composition, the relative effects of different treatments can be estimated from a reasonable amount of experimentation only if statistical science is exploited to the full. He then briefly described a number of problems from his own experience in which statistical methods had been of great assistance, and gave numerical results from typical experiments. Simple t-tests had been found useful in studies as varied as an inquiry into the effects of surface treatment and abrasion on the corrosion-rate of tinplate, and tests of the control of 'gumming' in plums by boric acid treatment of trees. In an investigation of the extent to which sulphur, phosphorus and copper in tinplate influence the formation of 'hydrogen-swells' during the storage of canned fruit, correlation and regression methods had been used for examining the interrelationships of the many factors. Correlation methods had also shown a close association between seasonal rainfall and gum production in plums. Analysis of variance had been particularly valuable for data from field and orchard trials, such as those concerned with spraying for disease control. Mr. Adam pointed out that statistical analysis assists the critical appreciation of data, but should never be regarded as a substitute for accurate chemical analysis.

A paper by Dr. K. L. Blaxter (Ministry of Agriculture and Fisheries Veterinary Laboratory) on "The Evaluation of the Nutritive Value of Animal Feeding-Stuffs" was read by Dr. Allcroft. Dr. Blaxter stressed the great variation found in the constitution of feeding stuffs, in the ability of individual animals to utilize their food, and in the requirements of individuals for different nutrients. He mentioned the possibility of controlling animal variation by the selection of homogeneous groups for experimentation; this is less easy for farm animals than for small laboratory animals, but even where it is possible it may have disadvantages in limiting the applicability of conclusions. By careful planning (which must not be thought an excuse for shoddy experimental technique), a factorial design permitting the estimation of components of variation from different sources may be chosen. The measuring of variation is complementary, not antagonistic, to its minimizing; by its aid is obtained a wider basis for inductive reasoning from the results. He had found change-over designs, in which each animal receives each diet for some period of the experiment, to be capable of measuring comparatively small treatment-effects with precision, and yet to give data for estimating effects under a variety of conditions. Often herds may respond differently to treatment-variants, so that unless experiments are replicated over several herds there can be no assessment of the consistency of treatment-effects. The experimenter's ideal should be to discover the mechanisms of cause and effect underlying all variation. Until that knowledge was attained, Dr. Blaxter considered efficient experimental design and the reduction of the results by the best statistical techniques to be essential in the study of the complex problems of animal nutrition.

Mr. E. H. Steiner (British Food Manufacturers' Research Association), in a paper entitled "Application of Statistical Methods in Calculating Proportions of Ingredients in Certain Food Products", discussed a more specialized problem. He showed how knowledge of the natural variations in the composition of food ingredients can be used, in conjunction with the results of analysing a sample of a compound food, so as to provide an estimate of the range within which the proportion of a particular ingredient is likely to lie; an arbitrary standard of probability has to be chosen, and is usually 95 per cent. Mr. Steiner then gave tables showing limits of error under specified conditions of variability in the ingredients, and described how allowance can be made for the experimental error of analysis. He mentioned the application of this method to the estimation of meat in pork sausages, in which cereals also contribute to the protein content, and the proportion of animal protein has to be obtained. By widening the limits of error, the chance that a product is wrongly condemned is reduced; but, on the other hand, products below standard are then more likely to escape condemnation.

These papers provoked a spirited discussion. Mr. P. Lyle spoke of a rapid method for estimating the mean and standard deviation of a normal distribution from a table of frequencies. If a table of cumulative frequencies is formed, and the corresponding ratios plotted on specially ruled probability paper, the resulting points will lie approximately on a straight line; the 50 per cent value of this line gives the mean of the distribution, and the reciprocal of its slope is the standard deviation. He said that he had generally found methods of regression analysis to give a more readily understandable representation of results than the calculation of correlation coefficients. From a slightly different point of view, this matter was also raised by Mr. Clayson, who criticized the correlation between rainfall and percentage 'gumming' quoted by Mr. Adam; he said that since 'gumming' was caused by bacterial infection of the trees, no meaning could be given to the rainfall correlation. In reply, Mr. Adam stated that not all 'gumming' could be attributed solely to bacterial causes; he and other speakers also pointed out that the existence of a correlation does not imply a direct causal relationship, but may be due to the two variates being to some extent dependent upon common causes. Mr. Leibmann mentioned the danger of drawing misleading conclusions from spurious correlations.

Dr. J. G. A. Griffiths questioned the practice of using a normal frequency distribution to represent the distribution of a measurement the range of variation of which is not infinite. He was particularly concerned about the probabilities of extreme values, and described the difficulty of using a statement of probability as the basis for legal action concerning the constitution of a food product; the assertion that a sample analysed had only a very small probability of occurrence in random sampling from a product that was up to standard might be countered in court by the claim that a rare chance could occasionally happen. He would prefer to argue on impossibility rather than on low probability, and would therefore like to make use of a distribution with finite range. Mr. Finney replied that even though a measurement is known not to be able to take an infinite range of values, the satisfactory determination of the extremes is not easy. For many purposes the normal distribution has been found a sufficiently good approximation, as the true limits of the distribution are so wide that even the assumption of normality allows an exceedingly small probability of their being surpassed. Furthermore, it can be demonstrated that the distribution of a mean of several observations will generally be much closer to normality than that of a single observation, and usually decisions will be taken only on mean values. He stated that the statistician would use other forms of distribution function when these are found to be more appropriate, but that often it is impracticable to obtain positive evidence of any other distribution fitting the material more closely than the normal. Mr. A. L. Bacharach suggested that a statement of the analyst's experience that "a value so extreme has never been found for a product *known* to be of satisfactory quality" would often be a more effective way of presenting evidence than a quotation of probability levels. Mr. E. C. Wood reminded the meeting that the choice of 5 per cent significance level is arbitrary, and that, for the purpose of an action at law, a more stringent criterion might be desirable.

Dr. Nicholls inquired about the possibility of combining evidence that a product is below standard; statistical analyses of sample determinations of two or more different constituents might show each to be below standard, though not significantly so, and a composite test would be needed in order to summarize the weight of evidence against the product. Mr. Steiner suggested that a combined index might be formed which would be more sensitive to discrepancies than any one of the measurements used in forming it. Mr. Wood mentioned the use of discriminant functions.

Mr. Wood emphasized that the statistical analysis of data need not require a great amount of tedious calculation. Often a simple preliminary examination of the figures will readily indicate the answers to all the main questions, and no complete analysis will then be needed; this is particularly likely when efficient experimental designs are used. Occasionally the full analysis might mean all the difference between obtaining unreliable, or even misleading, information from an experiment, and obtaining a sound and detailed interpretation of the data; in an investigation for which the experimental work had taken a much longer time, a few hours of computing might be a small price to pay for valid conclusions.

As a simple example of the planning of experimentation, Mr. Wood said that the practice of combining a number of independent samples of a product into a single bulk, from which duplicate sub-samples are drawn for chemical analysis, leads only to an estimation of analytical variations; if, instead, the original samples are combined into two bulks, from each of which a single sub-sample is drawn, the difference between the sub-samples also estimates the true sampling variability of the product.

Mr. K. A. Brownlee spoke of the importance of ensuring that so-called 'duplicate' analyses are really based upon repetition of all the analyst's procedure, and are not merely obtained by simultaneous parallel chemical analyses of two sub-samples under practically identical conditions; for many purposes the co-operation of different workers, and even of different laboratories, is necessary if the true variability of an analytical technique is to be assessed.

D. J. FINNEY

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixty-fifth meeting of the French Association for the Advancement of Science was held at Nice during September 9–14, 1946, under the presidency of Prof. Paul Montel. The opening meeting was held in the great hall of the Centre Universitaire Méditerranéen, which had been placed at the disposal of the Congress, and served as the general headquarters. Speeches of welcome were made by the Préfet of the Alpes Maritimes, the Mayor of Nice, and by Prof. Mario Roques, who pointed out that although Nice had the reputation of being a town of pleasure, it was also a town for meditation and study. Then followed addresses by representatives of the foreign delegates to the Congress, including H. Munro Fox (Britain), de Selys-Longchamps (Belgium), Wavre (Switzerland), Burgers (Holland), Bydzovsky (Czechoslovakia), Sergescu (Rumania), and Kepinski (Poland). Finally, Prof. Montel delivered his presidential address on the role of mathematics in the ordinary life of individuals.

The afternoon was devoted to certain inter-sectional meetings at the Centre Universitaire, and the organisation of sectional programmes at the Lycée de Garçons which had just been rebuilt. Tuesday, Wednesday and Friday were occupied mainly by the work of the sections, but the proverbial hospitality of Nice was shown in the variety of entertainments arranged by the municipality, including a reception at the Villa Masséna and a concert at the Opéra. Thursday was devoted to an excursion to Monaco, including visits *en route* to the Mont Gros observatory and the famous Augustus Monument and Museum at La Turbie.

At Monaco the afternoon was spent at the Oceanographical Institute, where the Director, Commandant Rouch, gave an account of the work of the Institute. Afterwards a visit was paid to the Jardins Exotiques with their extensive collection of cacti and other xerophytes.

Saturday, the last day of the Congress, concluded with an address by Commandant Rouch on French oceanographers, from Pythéas to Charcot; he recalled that it was exactly ten years since the *Pourquoi Pas* disappeared with Charcot and his crew.

A special feature of the Congress was the number of papers dealing with local problems, and excursions were arranged by many of the sections, including those of geology, botany, biogeography, agronomy and forestry. There was, for example, a valuable day excursion in motor coaches ascending the mountains inland from Nice to a height of 1,700 metres to view the successive altitudinal zones of the forests (at a number of places the excursionists were not allowed to walk off the road owing to unexploded mines).

The Congress was attended by many foreign delegates and also by representatives of more than forty French academies and scientific societies. The British Association was represented by Dr. Edward Hindle, one of its general secretaries, and Prof. H. Munro Fox.

It was decided to hold the Congress for 1947 at Biarritz towards the end of September. Dr. L. Fage, professor at the National Museum of Natural History, was elected president, and Dr. Lavier, professor at the Faculty of Medicine, Paris, was appointed secretary. E. HINDLE

GROWTH OF MODERN PSYCHIATRY*

IN his three Salmon Memorial Lectures before the New York Academy of Medicine, Dr. D. M. Levy traced the growth of modern psychiatry and showed its influence on psychiatric thought. Dr. Levy commenced his career in the Illinois Institute for Juvenile Research in 1920. The study of delinquency was then very much under the influence of the work of Dr. William Healy, and was beginning to be applied to criminology. Healy himself was building upon the foundations laid by Meyer, Binet and Freud. Meyer had developed the view that behaviour is a reaction to environment, and under him psychiatry became the study of purpose and response. Binet had opened the way to the measurement of mental powers by his work on school-children, and Freud had stripped away illusions to show the real motivation behind conduct. The result of their impact upon Healy was his book, "Mental Conflict and Misconduct".

Dr. Levy showed the development of child guidance and demonstrated it by an interesting recital of a case which attended the clinic where he then worked. The different approaches to the child's problem were studied with earnestness and enthusiasm, so that one feels, as he said, that these were exciting days and even the smallest discovery was fascinating. He showed how the environmentalist exploited milieu psychology and the impact of social forces upon the child's behaviour; the psychometric testing revealed the individual's intellectual capacities, and the organic approach showed underlying physical disease. Although all these were rival methods, and to some extent still are, they have been integrated into teamwork which reveals the whole. Yet in spite of all its advances, child psychiatry is still in a formative phase.

In his second lecture, Dr. Levy discussed delinquency, and pointed out that here, on the whole, psychiatry has not made notable progress. This is partly because of the legal difficulties and the lack of institutions suitable to exploit the psychiatrist's recommendations.

Psychotherapy may be useful for the criminal, but it is prolonged, and an impractical treatment with present resources. The correction of environment is helpful, and group psychotherapy offers promise. Foster homes are useful in certain cases. When institutions are used, every member of the staff should have an understanding, non-authoritarian attitude. Delinquent children previously exposed to disciplinary measures are confused when they breathe this new air. They suspect trickery, try to discover the weak spots, attempt to escape or run amok. Finally they settle down and the remedial aspects of the new method appear.

Dr. Levy traced the gradual advances from dungeon to prison, from prison to reformatory, and showed that this was an evolution of society's attitude to the criminal from primitive vengeance, graded punishment according to the seriousness of the offence, then the acceptance of some responsibility for the delinquent behaviour, and at last to the attempt to reform him. Modern psychiatry regards crime as something curable, something from which the criminal suffers. Reform in Britain has progressed farther than in the United States, but America leads in psychiatric study and treatment. He deplored the fact that psychiatry is so often neglected, and pointed out that many penitentiaries still have no psychiatric service.

Dr. Levy discussed the inroads which lay-psychotherapists are making into psychiatry; he fears that they will cause a permanent lowering of standards.

In his last lecture, Dr. Levy demonstrated that psychiatry is progressing through various phases. At first the psychiatrist dealt only with the severe neuroses and psychoses. Then he tended to be consulted regarding personal problems by labour and management. The third phase would be an integration with industry, but it remains a remote possibility. He gave various interesting points regarding the relationship between foremen and workers. These have shown a gradual transition in behaviour. The first and most primitive type of relationship was when the foreman gave an order categorically. Dr. Levy called this authoritarian. A further step was when

* Substance of the Salmon Memorial Lectures delivered at the New York Academy of Medicine by Dr. David Mordecai Levy, director of the Information Control, Division Screening Centre, U.S. Army, Germany, on November 6, 13 and 20.

the foreman gave an order and explained the reason for it. This he designated transitional. Finally, when the foreman consulted the worker, asking for criticism and advice, this was a participating relationship. The older the factory and the closer the union between foreman and worker, the more the relationship tends to be a participating one.

Dr. Levy then turned to military psychiatry. This served its apprenticeship in the First World War, and in the Second World War was used much more extensively. Greater reliance was placed on sedation and abreaction. Many soldiers were saved in numerous useful capacities. Group therapy was possible, and better organisation of social contacts and recreation. Dr. Levy felt that this was distinctly an American contribution, although British psychiatrists have made it an essential part of therapy.

He then discussed personnel selection in Germany and the school where Germans are trained as interpreters, secretaries, investigators, clerks, etc. More than eight hundred have received training there. He pointed out that this gave a unique chance to observe the damage the Nazi regime had done to the national character and personal adjustments. The differences in the family environment between Nazis and non-Nazis were observable.

Dr. Levy believes that the field of political psychiatry is just emerging and will be helpful in the selection of leaders in the new Germany.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 6

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. H. R. Harbottle: "The Provision of Line Communications for the Fighting Services".

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. G. M. Bennett: "Nitration with Mixed Acids".

Tuesday, January 7

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 5) (succeeding Lecture on Thursday, January 9).*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. C. Hall and Mr. A. H. Taylor: "Chemical Engineering Aspects of the Fischer-Tropsch Process".

Wednesday, January 8

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (joint meeting with the SOCIETY FOR APPLIED BACTERIOLOGY, at the Medical Society of London, 11 Chandos Street, London, W.1), at 2.15 p.m.—Dr. J. G. Baumgartner: "Fermentation of Vegetables for Pickle Manufacture"; Dr. T. Richards: "Bacterial Lipolysis and Rancidity in Fats"; Dr. H. H. Evers: "Curing and Fermentation of Tobacco".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. J. H. Partridge: "The Story of Glass" (Dr. Mann Juvenile Lecture).

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Dr. A. P. Cawadias: "Clinical Science in the Light of History".

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p.m.—Mr. W. B. Reddaway: "The Census of Production".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. L. W. Leyland Cole: "Petroleum Products in Agriculture—The Role of Petroleum in Plant Protection".

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (joint meeting with the Local Sections of the SOCIETY OF CHEMICAL INDUSTRY and the INSTITUTE OF FUEL, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. E. Crossley: "The Inorganic Constituents of Coal".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. A. Mason: "Radio Transmitting Valves".

Thursday, January 9

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Miss F. B. Fairbrother: "Heating and Ventilation".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Mr. F. A. Robinson: "Recent Developments in Chromatography".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. E. G. H. Carter: "Testing as an Aid to Efficient Finishing".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. B. C. Saunders: "Toxic Fluorophosphonates and related Compounds"; Mr. N. J. Cartwright and Mr. R. D. Haworth: "Some Aspects of the Oxidation and the Dimerisation of Propenylphenols".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the Local Section of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Department, The University, Manchester), at 7.30 p.m.—Dr. J. H. Schulman: "On Molecular Interaction at Oil/Water Interfaces".

Friday, January 10

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester 3), at 1 p.m.—Mr. W. E. Swale: "Public Electricity Supply and its Application in the Cotton Textile Industry".

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Annual General Meeting. Mr. C. E. Rowe: "Aspects of Pilot Plant Development".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 23rd Duddell Medal to Dr. Karl Weissenberg; Presentation of the 2nd Charles Vernon Boys Prize to Mr. Robert W. Sutton; "Kelvin, Master of Measurement" (sound film).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. D. M. Smith: "The Development of an Axial Flow Gas Turbine for Jet Propulsion"; Mr. K. Watson Todd: "Practical Aspects of Cascade Wind Tunnel Research".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. A. Hancock and Mr. T. F. Brown: "Paint Settling—a Suggested Method for Determining the Settling Properties of Paints".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (joint meeting with the INSTITUTION OF ELECTRONICS, N.W. ENGLAND SECTION, in the New Physics Theatre, The University, Manchester), at 7 p.m.—Prof. D. R. Hartree, F.R.S.: "Recent Developments of Calculating Machines in U.S.A.".

TEXTILE INSTITUTE, BOLTON BRANCH (at the Municipal Technical College, Bolton), at 7.30 p.m.—Mr. G. K. Hughes: "Textiles and their Launderability".

INSTITUTE OF PHYSICS, MIDLAND BRANCH (at the Imperial Hotel, Birmingham).—Prof. J. M. Meek: "The Nature of the Electric Spark".

Saturday, January 11

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, N.W.8), at 10 a.m.—Twelfth Annual Meeting; at 10.45 a.m.—Papers on "Careers in Zoology—Possibilities and Training".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (joint meeting with the SOUTH WALES BRANCH OF THE INSTITUTE OF PHYSICS, in University College, Cardiff), at 3.30 p.m.—Dr. F. A. Vick: "Contact Potentials".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT STRUCTURAL ENGINEER (temporary) in the Ministry of Finance—The Assistant Secretary (Establishments), Ministry of Finance, Stormont, Belfast, quoting S.B.202/46 (January 10).

ASSISTANT TECHNICAL SECRETARY (male) by the Iron Making Division of the Association—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Iron Making Division' (January 11).

HEAD OF THE DEPARTMENT OF HORTICULTURE at the Yorkshire Institute of Agriculture, Askham Bryan, York—The Joint Clerk, Yorkshire Council for Agricultural Education, County Hall, Beverley, Yorks. (January 11).

EDITORIAL OFFICER for the Society's Journal and other publications—The Hon. Secretary, Society of Dyers and Colourists, 32-34 Piccadilly, Bradford, Yorks., endorsed 'Editorial Officer' (January 11).

GRADUATE MASTERS for Government Secondary Schools, Seychelles Islands, to teach (*a*) BIOLOGY AND GENERAL SCIENCE, (*b*) MATHEMATICS up to School Certificate standard and JUNIOR GENERAL SCIENCE, (*c*) GEOGRAPHY, HISTORY and CIVICS—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (January 11).

PROFESSIONAL FORESTERS in the New Zealand State Forest Service—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (January 12).

LECTURER IN HUMANITY in the United College, St. Andrews—The Secretary, The University, St. Andrews (January 15).

DIRECTOR OF RESEARCH—The Secretary, British Baking Industries' Research Association, Wellington House, 125-130 Strand, London, W.C.2 (January 15).

HEAD OF THE DEPARTMENT OF AGRICULTURAL ECONOMICS, and an ASSISTANT AGRICULTURAL ECONOMIST—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough (January 15).

LECTURER (male) IN AGRICULTURE, and an ASSISTANT POULTRY INSTRUCTOR (male or female)—The Director of Agriculture, School of Agriculture, Houghall, Durham (January 15).

SECRETARY—The Secretary, School of Agriculture, Cambridge (January 15).

LECTURER (Senior Assistant) IN STRUCTURAL ENGINEERING—The Principal, Dudley and Staffordshire Technical College, Dudley (January 17).

CHEMIST for development work, preferably with experience of chemical engineering, a RESEARCH CHEMIST with experience of plastics, and a RESEARCH CHEMIST with experience of sterols—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6 (January 18).

LECTURERS (2) IN THE DEPARTMENT OF CHEMISTRY of the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (January 18).

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT at the School of Engineering and Navigation, High Street, Poplar, London, E.14—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (January 18).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT of the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (January 18).

SENIOR ASSISTANT IN BACTERIOLOGY, and a SENIOR ASSISTANT IN PATHOLOGY, at the University of Cape Town—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (January 20).

PRINCIPAL OF GRANTHAM TECHNICAL COLLEGE—The Director of Education, County Offices, Sleaford, Lincs. (January 21).

LECTURER IN THE DEPARTMENT OF ENGINEERING of East Ham Technical College—The Chief Education Officer, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (January 25).

SENIOR CHEMIST (male)—The Clerk of the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (January 31).

STATISTICIAN to the Nuffield Department of Industrial Health—The Professor of Industrial Health, King's College, Newcastle-upon-Tyne (January 31).

ASSISTANT CURATOR at the Essex Museum of Natural History, Romford Road, West Ham—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (January 31).

RESEARCH ASSISTANT IN THE DEPARTMENT OF MARINE ENGINEERING AND NAVAL ARCHITECTURE—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

LECTURER IN APPLIED AND INDUSTRIAL CHEMISTRY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.1450.A.O. (February 8).

PROFESSOR OF ENGINEERING—The Registrar, University College, Singleton Park, Swansea (February 8).

LECTURER IN BACTERIOLOGY—The Registrar, The University, Sheffield (February 15).

PRINCIPAL—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (February 28).

CHAIR OF MINING AND METALLURGY in the Faculty of Engineering, University of Adelaide—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (March 1).

READER IN MARINE ENGINEERING at King's College—The Registrar, University Office, 23 St. Thomas Street, Newcastle-upon-Tyne (March 1).

PROFESSOR OF AGRICULTURAL CHEMISTRY—The Registrar, The University, Reading (March 17).

LECTURER IN COLONIAL AGRICULTURE—Prof. Blackman, Department of Agriculture, Parks Road, Oxford (April 20).

LECTURER IN ANATOMY in the University of Queensland, Brisbane—The Agent-General for Queensland, 409 Strand, London, W.C.2; The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2.

JUNIOR RESEARCH OFFICER for work on cloth geometry and related fields—The Director, Shirley Institute, Didsbury, Manchester 20.

LECTURER IN PHYSIOLOGY, and a DEMONSTRATOR OF PHYSIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

LABORATORY TECHNICIAN FOR PHYSICS LABORATORY—The Secretary, University College Hospital, Gower Street, London, W.C.1.

INDEXER AND ABSTRACTOR (woman) of technical publications relating to mineral resources—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

ASSOCIATE PROFESSOR OF CHEMISTRY AND PHYSICS at the Royal College of Medicine, Baghdad, an EXPERT IN ENTOMOLOGY, an ENTOMOLOGIST, and a SOIL TECHNOLOGIST—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.13724.

MEDICAL BIOLOGIST, Tanganyika (with experience in medical zoology, including parasitology, applied entomology and the epidemiology of parasitic and insect-borne diseases)—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Patent Medicines: an Indictment. By Hugh Linstead. Pp. 32. (London: National News-Letter, 1946.) 1*s*. [148

Department of Scientific and Industrial Research: Building Research. Technical Paper No. 28: Protractors for the Computation of Daylight Factors. By A. F. Dufton. Pp. 16. (London: H.M. Stationery Office, 1946.) 4*d*. net. [148

Monographs of the Quekett Microscopical Club. No. 2: Introduction to the Electron Microscope. By F. E. J. Ockenden. Pp. 24+8 plates. (London: Williams and Norgate, Ltd., 1946.) 2*s*. 6*d*. net. [148

Memorandum on Patent Law Reform. By Joint Chemical Committee. Pp. 118. (London: Association of British Chemical Manufacturers, 1946.) 3*s*. [148

Education (Scotland). Report for the Year 1945 by the Director of the Royal Scottish Museum, Edinburgh. Pp. 12. (Edinburgh: Royal Scottish Museum, 1946.) [148

British Institution of Radio Engineers. Annual Report and Accounts, 1945–6. Pp. ii+14. (London: British Institution of Radio Engineers, 1946.) [158

The Agricultural Development of the Middle East. By Dr. B. A. Keen. A Report to the Director General, Middle East Supply Centre, May 1945. Pp. xii+126+15 plates. (London: H.M. Stationery Office, 1946.) 5*s*. net. [158

Middle East Science: a Survey of Subjects other than Agriculture. By E. B. Worthington. A Report to the Director General, Middle East Supply Centre, August 1945. Pp. xiii+239+16 plates. (London: H.M. Stationery Office, 1946.) 7*s*. 6*d*. net. [158

Soviet Science in the Service of the People, by S. I. Vavilov, and An Outline of the History of the Academy of Sciences of the U.S.S.R., by V. L. Komarov. (Illustrated Soviet Booklets.) Pp. 64. (London: Soviet News, 1946.) 1*s*. 6*d*. [208

Ministry of Agriculture and Fisheries. Bulletin No. 120: Root Vegetables. Pp. 24+4 plates. (London: H.M. Stationery Office, 1946.) 9*d*. net. [208

Other Countries

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 1007: Surface Water Supply of the United States, 1944. Part 7: Lower Mississippi River Basin. Pp. vii+378. 60 cents. Water-Supply Paper 1009: Surface Water Supply of the United States, 1944. Part 9: Colorado River Basin. Pp. vii+360. 55 cents. Water-Supply Paper 1010: Surface Water Supply of the United States, 1944. Part 10: The Great Basin. Pp. v+181. 35 cents. Water-Supply Paper 1011: Surface Water Supply of the United States, 1944. Part 11: Pacific Slopes in California. Pp. viii+405. 60 cents. Water-Supply Paper 1014: Surface Water Supply of the United States, 1944. Part 14: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. v+222. 40 cents. (Washington, D.C.: Government Printing Office, 1945–1946.) [158

Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December 1945. Pp. ii+17. (Entebbe: Government Printer, 1946.) 2*s*. [208

U.S. Department of the Interior: Geological Survey. Professional Paper 205-B: Minerals of the Montmorillonite Group; their Origin and relation to Soils and Clays. By Clarence S. Ross and Sterling B. Hendricks. (Shorter Contributions to General Geology, 1943–44.) Pp. iv+23–80+8 plates. (Washington, D.C.: Government Printing Office, 1945.) 35 cents. [218

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 971: Surface Water Supply of the United States, 1943. Part 1: North Atlantic Slope Basins. Pp. x+613. 1 dollar. Water-Supply Paper 972: Surface Water Supply of the United States, 1943. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. viii+503. 1 dollar. (Washington, D.C.: Government Printing Office, 1945.) [218

Durban Museum and Art Gallery. Annual Report for the Year ended 31st July 1945. Pp. 8 + 4 plates. (Durban: Durban Museum and Art Gallery, 1946.) [278

Universidad de Buenos Aires: Facultad de Agronomia y Veterinaria. Publicacion No. 2: Resefia de la sanidad vegetal en la Republica Argentina. Por Prof. Juan B. Marchionatto. Pp. 117. Tomo I, Fasicolo 1: Oftalmia periodica. Por Prof. Alvaro S. Camporl. Pp. 69. (Buenos Aires: Universidad de Buenos Aires, 1945–1946.) [278

South African Journal of Science. Vol. 42: Being the Report of the Forty-third Annual Meeting of the South African Association for the Advancement of Science, Johannesburg, 1945, 2nd, 3rd and 4th July. Pp. xxiv + 273. (Johannesburg: South African Association for the Advancement of Science, 1946.) 30*s*. net. [278

Annual Report of the Research Council of Alberta, 1945. (Report No. 47.) Pp. 21. (Edmonton: King's Printer, 1946.) [278

Research Council of Alberta. Contribution 10: Recent Work of the Research Council of Alberta. By Edgar Stansfield. Pp. 12. (Edmonton: King's Printer, 1945.) [278

Smithsonian Miscellaneous Collections. Vol. 104, No. 23: The Cedartown, Georgia, Meteorite. By Stuart H. Perry. (Publication 3844.) Pp. ii + 4 + 4 plates. Vol. 106, No. 1: The Birds of San José and Pedro Gonzáles Islands, Republic of Panamá. By Alexander Wetmore. (Publication 3845.) Pp. ii + 60 + 4 plates. Vol. 106, No. 8: Turtles collected by the Smithsonian Biological Survey of the Panamá Canal Zone. By Karl Patterson Schmidt. (Publication 3852.) Pp. ii + 9 + 1 plate. (Washington, D.C.: Smithsonian Institution, 1946.) [278

Smithsonian Institution: Bureau of American Ethnology. Bulletin 137: The Indians of Southeastern United States. By John R. Swanton. Pp. xiii + 943 + 107 plates. (Washington, D.C.: Government Printing Office, 1946.) 2.75 dollars. [278

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1944. Pp. iii + 100. 35 cents. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1945. Pp. iii + 112. 25 cents. (Washington, D.C.: Government Printing Office, 1945–1946.) [278

U.S. Office of Education: Federal Security Agency. Vocational Division Bulletin No. 234, General Series No. 7: Vocational Education in the Years Ahead. A Report of a Committee to Study Postwar Problems in Vocational Education. Pp. xiv + 329. (Washington, D.C.: Government Printing Office, 1945.) 50 cents. [278

Catalogues

Classics of Science and Medicine. (Catalogue 125.) Pp. 138. (London: Davis and Orioli, 1946.)

A List of the Publications of the Ray Society. Pp. 4. (London: Bernard Quaritch, Ltd., 1946.)

A Catalogue of Books on Zoology, Geology and Palaeontology, Botany, and a Selection of Herbals. (No. 640.) Pp. 96. (London: Bernard Quaritch, Ltd. 1946.) 6*d*.